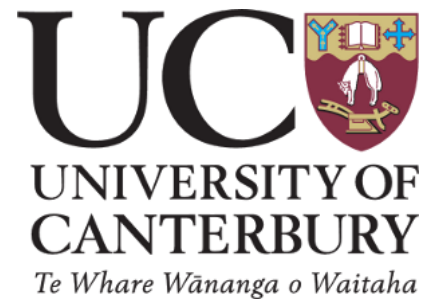


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Generating actionable intelligence and meaningful data from a Smart Cities project

Master of Science in Geography

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Abstract

Smart cities utilise new and innovative technology to improve the function of the city for governments, citizens and businesses. This thesis offers an in-depth discussion on the concept of the smart city and sets the context of smart cities internationally. It also examines how to improve a smart city through public engagement, as well as, how to implement participatory research in a smart city project to improve the level of engagement of citizens in the planning and implementation of smart projects. This thesis shows how to incentivise behaviour change with smart city technology and projects, through increasing participation in the planning and implementation of smart technology in a city. Meaningful data is created through this process of participation for citizens in the city, by engaging the citizens in the creation of the data, therefore the information created through a smart city project is created by and for the citizens themselves. To improve engagement, a city must understand its specific context and its residents. Using Christchurch, New Zealand, and the Christchurch City Council (CCC) Smart City Project as a case study, this research engages CCC stakeholders in the Smart City Project through a series of interviews, and citizens in Christchurch through a survey and focus groups. A thorough literature review has been conducted, to illuminate the different definitions of the smart city in academia, business and governments respectively, and how these definitions vary from one another. It provides details of a carefully selected set of relevant smart cities internationally and will discuss how the Christchurch Earthquake Sequence of 2010 and 2011 has affected the CCC Smart City Project. The research process, alongside the literature review, shows diverse groups of citizens in the city should be acknowledged in this process. The concept of the smart city is redefined to incorporate the context of Christchurch, its citizens and communities. Community perceptions of smart cities in Christchurch consider the post-Hayden Slaughter

disaster environment and this event and subsequent rebuild process should be a focus of the smart city project. The research identified that the CCC needs to focus on participatory approaches in the planning and implementation of smart projects, and community organisations in Christchurch offer an opportunity to understand community perspectives on new smart technology and that projects internationally should consider how the context of the city will affect the participation of its residents. This project offers ideas to influence the behaviour change of citizens through a smart city project. Further research should consider other stakeholders, for instance, innovation and technology-focused business in the city, and to fully engage citizens, future research must continue the process of participatory engagement, and target diverse groups in the city, including but not limited to minority groups, older and younger generations, and those with physical and mental disabilities.

Abbreviations

ICT	–	Information and communication technology
CCC	–	Christchurch City Council
CBD	–	Central business district
ASC	–	Amsterdam Smart City
SU	–	Smart urbanism
IoT	–	Internet of Things
IT	–	Information technology
PTSD	–	Post-Traumatic Stress Disorder
SVA	–	Student Volunteer Army
KC	–	Knowledge City
UCSA	–	University of Canterbury Students Association
PGSA	–	Post-Graduate Students Association

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Chapter 1: Introduction

1 Background

Smart cities are a new concept in governments, city planning, and academic literature (Kitchin, 2015). They are, in their simplest forms, cities that utilise information and communication technology (ICT) to improve the function (waste management, electricity use, the use of spaces) of the city, and its usability for its citizens, or visitors. The Christchurch City Council (CCC) is working on initiatives to develop smart city projects in the city. This involves making a city that is; smart, using new technology to inform the planning and function of the city (Kitchin, 2014); safe, with improved physical safety, and personal data security for the users of the city (Lazaroiu & Roscia, 2012); and, well-functioning, with city systems that improve the cities usability and reduce the cost of city functions like waste removal, and traffic management systems (IBM, 2013). This will be achieved using a variety of tools to display information like SmartView (Christchurch City Council, 2018), a website application to display information about the city, including maps, environmental information and news. This thesis will focus on understanding how to create meaningful data through the Christchurch City Council's Smart City Project, make this data actionable to the target audience; the city's users, community groups and residents. This research will use stakeholder interviews, a community survey and focus groups to gather data from residents and visitors to Christchurch city to understand community desires relating to the Smart City Project in Christchurch City. It also aims to provide examples for national and international smart cities, to improve engagement and participation in smart cities elsewhere. The Christchurch City Council's Smart City Project is a section of the CCC attempting to implement smart projects in Christchurch City to improve its function and usability for its residents and visitors. Meaningful, in relation to this research, refers to data which is considered useful, by the target audience and is easy to use, meaning the

city's design, layout and accessibility will positively affect the user's experience in the city. Actionable means the information will be actively used by the target groups, it will promote behaviour change among residents and community groups. Furthermore, these groups will willingly contribute through a process of co-creation to improving the quality of information used in the project. The information available from the Smart Cities Project must have a positive influence on the lives of the users of Christchurch, improving how they experience the city, and this thesis will aid in achieving this in the long term, offering insight for future projects. The topic of smart cities is emerging from a small and growing pool of literature, with the concept first used in the 1990's (Höjer & Wangel, 2014), or even further back to the early 1900's when the idea to use technology to improve the cities function was first discussed with the conception of an ideal city in the industrial era, being healthy and functional (Angelidou, 2015). This research will attempt to understand community perceptions of the CCC Smart City Project and use these to offer suggestions for improvement.

This project is in collaboration with The Christchurch City Council Smart Cities Project and will understand and explain community perceptions of the smart projects being implemented in Christchurch. It will also discuss new projects and ideas that could support the Smart City Project, based on community engagement strategies, including stakeholder interviews, a community survey, and focus groups. All of the research has been informed by The Smart City Project, offering background information and suggestions on the research project's aim and objectives to support the goals of the project. This project will aim to understand community perspectives in Christchurch relating to smart cities and will engage communities directly in the CCC Smart City Project, offering solutions to influence user's behaviour change. It will also suggest ways in which smart city projects elsewhere, nationally and internationally can engage communities in their planning and implementation strategies.

2 Aim and Objectives

The aim was developed based on research gaps acknowledged in the initial stages of the literature review which will be discussed in the coming section. The objectives of this project have been developed in collaboration with The Christchurch City Council's Smart City Project, with their input influencing questions asked, and specifically in developing objective number four below, in order to address the aim and aid in the success of the smart projects that directly impact the users (residents and visitors) of Christchurch City. These are as follows:

Aim:

To suggest ways to create actionable and meaningful data for residents and visitors in the city from the information gathered in Christchurch's Smart City Project.

Objectives:

- (1) To review the Smart Cities Project in Christchurch in relation to national and international examples, offering examples from these that can be incorporated into the Smart City Project in the city.
- (2) To understand ways to communicate these smart cities technologies to effect behaviour change, including how to consult communities in the city about smart city technologies, how to circulate information relating to these projects, and what sort of projects will be most meaningful to the users, residents and visitors, of the city.
- (3) To understand community perceptions of the Smart City Project in Christchurch, what they wish to gain from current Smart Cities projects like SmartView, and what new projects they would like to see in the city.

- (4) To provide recommendations for the City Council to create actionable and meaningful data for the smart cities project, from community perceptions gained through the research process, and national and international examples of smart city projects.

3 Thesis Outline

This thesis project will be split into six chapters; Introduction, literature review, methodology, results, discussion and conclusion.

The introduction section has provided the main details of the project, highlighting the key aim and objectives of the project, the context for the research, and the overall structure of the thesis report.

Chapter one, the literature review section, compiles the research from academic, governmental and organisational sources relating to smart cities, and offers an in-depth understanding of the complexities of the definition of smart cities, as well as gaps in the current research. It answers objective one shown above, through discussing four widely discussed and successful existing smart cities or smart city projects nationally and internationally, Barcelona, Amsterdam, Singapore and Wellington (Barcelona City Council, 2017) (Amsterdam Smart City, n.d) (Smart Nation Singapore, 2017) (Wellington City Council, 2011), and relating these to Christchurch. The history of smart cities concept is discussed briefly, including how they have developed through time and various different iterations of the concept, including the wired city, intelligent city, and knowledge city. Christchurch city is then analysed, to understand the context in which

the Smart City Project will be operating. Finally, current smart projects in Christchurch will be discussed.

The methodology section in chapter two discusses the process in which the research was conducted. It discusses the three modes of research employed, semi-structured stakeholder interviews, surveys, and focus groups, gives full details on the data collection process. It discusses the rationale as to why each method was used, and how they will be analysed in the coming results section. This section then discusses the main smart projects that have been focused on in this thesis, SmartView, smart mobility parking, and central city free Wifi, and why this was the case.

As mentioned, the results chapter of this thesis report discusses the data gathered and analyses them to answer objectives two and three. The data are shown in tables and graphs to display how Christchurch citizens perceive the concept of the smart city, and the three smart projects suggested. The results are broken into three sections, the stakeholder interviews, the survey results, and the focus group results. The stakeholder interviews predominantly aim to understand the purpose of the Smart City Project as a whole, and how those involved in the project perceive the concept of the smart city. The surveys gather a broader amount of information from Christchurch City users, about their use of the city, how new smart projects could affect this, and what they would like to see from the Smart City Project. Finally, the focus groups aim to further understand individuals reasoning for the results found through the surveys, including their current perception of technology in the city and what smart projects they would or would not use. These results are then compared, leading into the next chapter.

The discussion chapter draws from the literature review and results sections to provide clear answers to all of the objectives, and the aim of this project. It draws on the key points discussed in each of these sections to provide a clear picture of community perspectives relating to the Christchurch City Council Smart City Project. This is broken into four sections, redefining the smart city, community perspectives of smart projects, suggestions for Christchurch City and the Smart City Project, and limitations and suggestions for further research.

The conclusion will revisit the key points mentioned, and attempt to offer ways to transfer the information gathered in Christchurch's Smart City project into actionable and meaningful data for residents and communities in Christchurch, and provide examples to support future smart city projects internationally, specifically on how to involve and engage local community in the projects.

Chapter 2: Literature Review

1 Introduction to the literature

The smart city is a complex, widely debated, and controversial concept in urban planning and city management. No single definition exists for the term ‘smart city’, rather, it has been used interchangeably by the government, businesses, and academics for a plethora of different purposes (Kitchin, 2015). On top of this, smart cities are simultaneously understood as cities; that are increasingly composed of ICT including pedestrian movement sensors, weather stations, and innovative technology; and cities that are concerned with the development of economy and governance by innovation, creativity, entrepreneurship, and of smart people (Kitchin, 2014). Both definitions, while causing debate in the literature, maintain a focus on new and innovative technology working to improve the city in some way. Other challenges in the realm of smart city research exist, including issues with top-down and bottom-up management, where city governments are making decisions about the city, for the users of the city, without consultation, or where communities lack the means, technology or expertise to implement smart projects they deem beneficial for them or their community; and governance of the smart city (Höjer & Wangel, 2014). This chapter will develop on these points, discussing the concept of the smart city, and attempt to outline the problems and limitations arising in the current literature surrounding the topic. First, a discussion expanding on the history of the smart city will be conducted, and definitions from the literature will be acknowledged and compared. Second, definitions of smart cities from the literature will be outlined, and four case studies of national and international cities that have, or are incorporating elements of smart city design in their planning and management will be analysed. Third, the current context of Christchurch city will be examined, acknowledging the 2010 and 2011 earthquake sequence and its effect on the city and responses post-disaster. This section will understand the concept of smart cities

in relation to Christchurch will be made, with the focus of the user of the city, its residents and the community (Marek, Campbell, & Bui, 2017). Finally, the current state of the Smart City Project in Christchurch, including projects they are planning, trialling or implementing and the process in which this occurs, will then be discussed. Specifically, three current smart projects in the city will be detailed, SmartView, Sensibel, and the Big Belly Solar bins, to offer insight into the process the Smart City Project takes in trialling these projects. This will be informed by definitions in current smart city literature in relation to the context of this research project, and the context of Christchurch city.

This literature review has involved research to answer the aim; to suggest ways to transfer the information gathered in Christchurch's Smart City project into actionable and meaningful data for residents and communities in Christchurch; and objectives of the thesis project, predominantly objective one. This being;

- (1) To review the Smart Cities Project in Christchurch in relation to national and international examples, offering examples from these that can be incorporated into the Smart City Project in the city.

The following sections will develop on this objective and will set the context for this thesis project, and will highlight a gap in the literature that this thesis will address, how can smart city projects, like the CCC Smart City Project, engage communities in their planning and implementation?

2 Defining the ‘Smart City’

Since the 1980s, the smart city as a concept has developed through a variety of iterations, from the wired city (Hollands, 2008), to the knowledge city (Yigitcanlar, O’Connor, & Westerman, 2008), concepts which will be explained further in this literature review, into the widely debated idea it is today (Glasmeier & Christopherson, 2015), as a product of the differing opinions and uses for smart cities by corporations and academics. However, many established smart city concepts can be traced back to literature published in the late 19th century (Marek, Campbell, & Bui, 2017), although not titled as smart cities, the historical root of the concept is uncertain, contributing to the inherently complex nature of smart cities and their definitions. This section will illuminate on details of the history of smart cities to understand the origin of the topic and how it has developed over time, and offer a number of definitions arising throughout literature to inform the creation of a new definition of a smart city for the CCC Smart City Project. It will develop on the idea of the smart city as a concept, how this has changed over time, and how it will continue to evolve into the future, as technology is ever changing and improving through science and innovation, and smart cities will continue to evolve along with future technological advancements.

It should be noted that this is not the definitive history of the smart city, as the concept has gone through many iterations over time, and the definition is still contested in the literature between academics, corporations, and governments. However, this section will discuss some historical events relating to the smart city concept, attempting to illuminate a variety of definitions that have arisen throughout history.

2.1 History and origins

The smart city concept is still a fairly new and developing concept in academia and government planning. It has roots deeply seeded in history, dating as far back as the late 19th century (Angelidou, 2015), when the discussion first arose around the health and functionality of the city. Following this, through advances in technologies like the automobile, cameras, hydro-electric power, air travel and so on, the initial framework for the influence technology has on the city began to be discussed. Communication technologies began to improve, and transport, as well as cities daily functions such as waste management, energy use, and road networks, became more influenced by new technology in the city, through the use of new systems of communication and connections between services. Between 1960 and 1980 a large body of work was being published relating to the information society, with the advent of concepts such as cybernetically planned cities in the 1960's (Höjer & Wangel, 2014), the wired city (Hollands, 2008), information cities, knowledge cities (Yigitcanlar, O'Connor, & Westerman, 2008) and many others (Angelidou, 2015). Further to this, we saw a number of specific developments shaping the understanding of the smart city concept. Developments such as; the globalization of environmental problems and sustainable development; urbanization and urban growth; sustainable urban development and sustainable cities; new information and communication technologies connecting more people in easier and more user friendly ways; and, the first definitions of the smart city itself through city planners acknowledging the impact new ICT can have on the functionality and design in the city (Höjer & Wangel, 2014). From these points, the smart city as a concept has been shaped to acknowledge developing technologies in each of these areas and has to understand how to utilise these new technologies within the city to move toward the idea of the future city (Eteszadzadeh, 2016).

These events have shaped our understanding of the term smart city over time, going through a number of iterations since first coined in the 1990's through the Smart Growth Movement (Höjer & Wangel, 2014). Below, various definitions of the smart city will be highlighted, and shown in respect to three separate groups, academia, business, and government, to highlight a gap in the literature that will be assessed further in this thesis project. This gap being, these three groups have, through history, been divided about the definition of the smart city (Marek, Campbell, & Bui, 2017). The potential reasons for this division will be discussed, but is important to acknowledge as each group tends to focus their definition on different elements of the smart city, with three separate interpretations of smart cities, defining this for Christchurch is difficult, and all three groups definitions should be understood to fully grasp how smart cities are understood internationally to inform the definition in Christchurch.

2.2 Definitions

As discussed, three predominant groups through literature have offered definitions for the concept of the smart city. These being, academia, business, and government, and each group tends to focus their definitions differently. For instance, academia considers the smart city has a functionality focus in a city, aiding in improving basic city systems like waste management and energy use, whereas governments tend to see smart cities a tool to improve the use of the city for its users, and business focus on the economic value of smart technology in the city. Table one and two, as well as the subsequent section, highlight some of the definitions throughout the reviewed literature.

2.2.1 Academic and organisational definitions

Table 1: Academic definitions of the smart city

Title and author	Definition
(Höjer & Wangel, 2014) <i>Smart Sustainable Cities: Definition and Challenges</i>	Definition for a “Smart Sustainable City”: “A Smart Sustainable City is a city that — meets the needs of its present inhabitants — without compromising the ability for other people or future generations to meet their needs, and thus, does not exceed local or planetary environmental limitations, and — where this is supported by ICT.” – (p. 10)
(Lazaroiu & Roscia, 2012) <i>Definition methodology for the smart cities model</i>	“The smart city is a new way of leaving and considering the cities. The optimization of available and new resources, as well as of possible investments is required. The achievement of smart city objective can be reached through the support of various information and communications technologies. These can be integrated in a solution considering the electricity, the water and the gas consumptions, as well as heating and cooling systems, public safety, wastes management and mobility.” – (p. 326)
(Eteszadzadeh, 2016) <i>Smart City - Future City?: Smart City 2.0 as a Livable City and Future Market</i>	“Smart City 2.0 can therefore be described as follows: It is a community aimed at individual and urban (self-) preservation comprising all groups of human urban stakeholders. Their behavior (including production and consumption) is completely geared to the urban goal system jointly developed by all of them on the basis of the city’s meta-goals (sustainability and generalizability). They are committed to their diverse community goals, champion their sovereignty as consumers, residents, and humans, as well as the protection of their city’s natural environment and wildlife. To achieve this, they employ technical facilities to a great extent, but do not allow technology to expand uncontrollably, dominate urban life, or acquire decision-making authority.” – (p. 53)
(Kitchin, 2014) <i>The real-time city? Big data and smart urbanism.</i>	“The term ‘smart city’ has been variously defined within the literature, but can broadly be divided into two distinct but related understandings as to what makes a city ‘smart’. On the one hand, the notion of a ‘smart city’ refers to the increasing extent to which urban places are composed of ‘everyware’ (Greenfield 2006) ... On the other hand, the notion of a ‘smart city’ is seen to refer more broadly to the development of a knowledge economy within a city-region (Kourtit et al. 2012).” – (p. 1-2)

	<p>“...five main characteristics of a smart city as evidenced by industry and government literature: widespread embedding of ICT into the urban fabric; business-led urban development and a neoliberal approach to governance; a focus on social and human dimensions of the city from a creative city perspective (Alia Florida 2004); the adoption of a smarter communities agenda with programmes aimed at social learning, education and social capital; and a focus on social and environmental sustainability.” – (p. 2)</p> <p>The definition is further developed in <i>Making sense of smart cities: addressing present shortcomings</i> (Kitchin, 2015).</p>
(Luque-Ayala & Marvin, 2015) <i>Developing a critical understanding of smart urbanism?</i>	<p>Smart urbanism (SU) rather than cities, related to smart cities more reactive in nature. Considers how to use smart technology to respond to change in a city:</p> <p>“SU, it is argued, provides a flexible and responsive means of addressing the challenges of urban growth and renewal, responding to climate change, and building a more socially inclusive society (European Commission, 2012).” – (p. 2105-2106)</p>
(Angelidou, 2015) <i>Smart cities: A conjuncture of four forces</i>	<p>“The most integrated of the current approaches for smart and intelligent cities are based on advancing and realizing both urban futures and the knowledge and innovation economy. In these strategies, ‘smart’ technologies provide the capability for instrumenting physical spaces with the necessary means, not only for making the physical space itself, but also people and activities within it, more functional... In essence, integrated smart city strategies aim to connect the physical space of cities with the economic and social sphere – a connection that although clearly existing, has always been troublesome for scientists and policy makers...</p> <p>The integrated model of the smart city shown on the above figure works toward the following assets:</p> <ul style="list-style-type: none"> – Advancement of human capital: citizen empowerment (informed, educated, and participatory citizens), intellectual capital and knowledge creation ... – Advancement of social capital: social sustainability and digital inclusion ... – Behavioural change – sense of agency and meaning (i.e. the feeling that we are all owners and equally responsible for our city) ... – Humane approach: Technology responsive to needs, skills and interests of users, respecting their diversity and individuality ...”

(Batty, et al., 2012) <i>Smart cities of the future</i>	“We adopt here the definition that is coined by Caragliu, Del Bo, and Nijkamp (2009) which is summarised in Wikipedia: a smart city is a synthesis of hard infrastructure (or physical capital) with the availability and quality of knowledge communication and social infrastructure. The latter form of capital is decisive for urban competitiveness.” – (p. 486)
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Definitions in academia have a number of similarities. Although a plethora exists, table one highlights seven prominent definitions found in the academic literature about smart cities. To summaries, smart cities are ones that; optimise available resources to improve the overall functionality of the city (Eteszadzadeh, 2016; Lazaroïu & Roscia, 2012); use the knowledge of the cities citizens, the knowledge economy (Kitchin, 2014), to drive smart technology and innovation (Angelidou, 2015; Eteszadzadeh, 2016); will influence the behaviour of its citizens (Angelidou, 2015; Eteszadzadeh, 2016); and will be sustainable for future generations (Höjer & Wangel, 2014). The focus is typically centred around how urban design and infrastructure can achieve these goals but does understand the value of human participation and knowledge when a city is becoming smart, through the advancement of social and human capital, as discussed by Angelidou (2015).

Table 2: Organisational definitions of the smart city

Organisation and author	Definition
Cisco (Cisco, nd)	“Today’s cities face a variety of challenges, including job creation, economic growth, environmental sustainability, and social resilience. These issues, and others, can be mitigated through the adoption of scalable solutions that take advantage of information and communications technology (ICT) to increase efficiencies, reduce costs, and enhance quality of life. Cities that take this approach are commonly referred to as Smart Cities, or Smart+Connected Communities (S+CC.) While there may be many dimensions to consider when defining a smart city, at a simple level, it refers to a meticulously planned city that relies on IT as an enabler to solve many of its problems - from the use of sensors to smart grids and data analytics that allow city infrastructure and services to meet city problems and citizen demands efficiently and reliably.” (p. 4-5)
Siemens (Siemens, 2014)	“The current general opinion can be summarized as follows: a city is smart if it makes use of the “Internet of Things” and other intelligent systems to use its resources more efficiently and thus improve the lives of its citizens and enhance its own competitiveness. Fields that are relevant to this concept include energy, transportation, industry, and public administration. In addition, a smart city must be able to combine a host of different systems into a coherent whole; thus system integration is the order of the day.”
IBM (IBM, 2013)	“A Smarter City uses technology to transform its core systems and optimise finite resources. Because cities grapple on a daily basis for water, transportation, energy, public safety and many other systems, IBM is committed to a vision of Smarter Cities® as a vital component of building a Smarter Planet®. At the highest levels of maturity, a Smarter City is a knowledge-based system that provides real-time insights to stakeholders, and enables decision-makers to manage the city’s subsystems proactively.” – (p. 5)
HP (Hewlett-Packard Development Company, 2016)	“The smart city leverages diverse information and communication technologies to enable better business processes, help control costs, drive toward carbon neutrality, and encourage citizen interaction. This forward-looking city works to promote a healthy economy, attract people and businesses, help reduce environmental impacts, and make it easy for citizens to participate in political, economical, cultural, and social activities.” – (p. 1)

SAP (SAP, 2017)	<p>“Sensors, smart machines, and algorithms are helping optimize smart initiatives in transportation, infrastructure, sustainability, citizen empowerment, safety, and livability.</p> <ul style="list-style-type: none"> • Sensors monitor asset utilization and health, predicting potential issues and maintenance needs • Analysis of real-time data combined with historical data are helping government proactively manage assets and infrastructure • Predictive modelling and simulation is helping keep citizens safe through real-time situational awareness • In-memory computing is helping translate massive data into insightful information” (p. 8)
Intel (Callaghan, 2015)	<p>““Smart city” refers to the use of innovative technologies in complex urban environments to manage resources and infra-structure in a sustainable way and to create opportunities for growth.” – (p. 2)</p>

From table two, business definitions have highlighted. Six organisations with an interest in smart cities and technology have been mentioned, but similar to in academia, there are a variety of other organisations. Summarising the key points from these definitions, smart cities use technology to improve the function of the city (Callaghan, 2015; Cisco, nd; Siemens, 2014), similar to in academia, but in organisational definitions, this technology will create economic growth (Hewlett-Packard Development Company, 2016; Callaghan, 2015). The definitions vary from those discussed in table one mainly due to their focus on economic gain and the promotion of innovation and business opportunity. The definitions do share similarities to those in academia, supporting the sustainability of the city (Callaghan, 2015; Hewlett-Packard Development Company, 2016) or supporting citizen involvement and the knowledge economy in the city (Cisco, nd; IBM, 2013). The key difference here is the more prominent focus on the economy of the city.

2.2.2 *Governmental definitions of the smart city*

Governments, local and national tend to define smart cities less directly, rather the definition relates to the context of the city or area that government is operating within. The following definitions are directly from cities that are considered the forefront of the smart city movement, found on city council websites or in relevant reports and documents. The cities of Barcelona, Amsterdam, Singapore and Wellington have been focused on, as they have been credited as being the some of the ‘smartest’ cities in the world (Audain, 2017; Buntz, 2016; Frearson, 2017; Garfield, 2017; Harper, 2017). Wellington has also been included as it is also a city in New Zealand allowing for comparison with Christchurch.

Barcelona is a recurring example in the discussion of smart technologies and the city. Barcelona’s smart city project began in 2012, employing technologies across urban systems in the city ranging from waste management to transport technologies (Adler, 2016), although smart technology could be dated back to 1992, when Barcelona hosted the Olympic Games and installed 310 miles (around 500 kilometers) of fibre-optic cabling (McGrath, 2017). The Internet of Things (IoT) is a key concept in Barcelona’s case, a term first coined by Kevin Ashton in 1999 (Ashton, 2009). Like smart cities, the IoT has seen a variety of iterations through its life and is constantly evolving as technology changes and improves. Understood simply, the IoT is the idea that everything and everyone can be a part of the internet, everything is connected and can be linked, and the internet is the connection (Shariatmadari, Iraj, & Jäntti, 2017). Barcelona has implemented a variety of smart projects since 2012, including an ever-increasing number of Wifi hotspots around the city, smart meters to measure and optimise energy consumption, multi-modal transport infrastructure including bike share systems and electric vehicle advancements, sensors to direct car users to parking locations, among many

other initiatives (Adler, 2016). The economic benefits of these projects, at the beginning of 2016 were evident, with an estimated \$58 million USD being saved on water, parking fees nearing \$50 million in profits, and around 47,000 new jobs being created by the projects (Adler, 2016). This network of projects creates a phenomenal amount of data for the city, which in turn helps to optimise the function of the projects, and provides information for future planning of new projects in Barcelona. With a focus on Digital Transformation, Digital Innovation and Digital Empowerment, Barcelona continues to utilise smart technology as a driver for an open, agile and participatory city (Barcelona City Council, 2017).

“Amsterdam Smart City (ASC) is the innovation platform of the Amsterdam Metropolitan Area. It challenges companies, citizens, the municipality and knowledge institutions to submit and apply innovative ideas and sustainable solutions to urban challenges.” (I Amsterdam, n.d). Amsterdam Smart City is the organisation in Amsterdam central to the cities widely recognised work in the field of smart cities (Amsterdam Smart City, n.d). With a focus on seven key themes to enhance the function and usability of the city, ASC is a particularly transparent example of smart city planning. These seven themes are; Infrastructure and Technology; Energy, Water and Waste; Mobility; Circular City; Governance and Education; Citizens and Living; and the Smart City Academy (Amsterdam Smart City, n.d). Each theme offers examples of specific projects relating to it, as well providing an opportunity to comment on projects, leave ideas and requests for new projects, lists events relating to the theme and provides updates about the city. All smart projects in the city are interactive through their open sourced nature and process of consultation, meaning the user has the opportunity to remain involved in all aspects of each smart project. Along with this, the ASC provides a detailed overview of the organisation and of the projects for users of the city, and the key stakeholders involved (Amsterdam Smart City, n.d). The share number of projects visible on the ASC

website is astonishing, counting the number of projects listed on the Amsterdam Smart City website is difficult and is constantly increasing, partly due to the open sourced nature of the organisation, they allow anyone to list their own smart projects, encouraging participation and innovation and supporting these individual's projects, for the better of the users of the city. This is different to any other smart city programme assessed, as they usually look at larger scale and government implemented smart projects, yet here there are many small community developed applications and events that are listed. Therefore, the ASC is acting as a network of smart projects in Amsterdam, creating a sort of Internet of Things as discussed above. Amsterdam is a key city in understanding the value of participation in the smart city process.

Singapore wants to be known as an "Intelligent Island" and aims to achieve this through Information Technology (IT) and smart city design (Mahizhnan, 1999). The city-state of Singapore has been acknowledged for its successful urban development with limited resources specifically land and therefore locally sourced natural resources, as it is an island state. It has made impressive developments through biophilic urbanism, technology advancements and transport innovation (Neville, 1999) (Future Cities, n.d) (Newman, 2014). Singapore has acknowledged the value of IT in moving from a developing nation to an advanced one (Mahizhnan, 1999), a Smart Nation. This idea of a Smart Nation;

“...is one where people are empowered by technology to lead meaningful and fulfilled lives. Through harnessing the power of networks, data and info-comm technologies, we seek to improve living, create economic opportunity and build a closer community. A Smart Nation is built not by Government, but by all of us - citizens, companies, agencies. This website chronicles some of our endeavours and future directions. A Smart Nation is built not by Government, but by all of us - citizens, companies, agencies.” (Smart Nation Singapore, 2017).

Smart Nation Singapore highlights five key domains which have an impact on citizens and society; transport, home and environment, business productivity, health and enabled aging, and public-sector services (Smart Nation Singapore, 2017). The city-state puts emphasis on education, infrastructure, and an economy that focus on technology and innovation (Mahizhnan, 1999), for example, education focused on IT and the use of computers is becoming more common, and all households aimed to have mandatory broadband connections in homes by 2000. In one case, Singapore was named Global Smart City in 2016 (Juniper Research, 2016) and remains prominent in the field of smart city research. Singapore is often also credited with being one of the most liveable cities in the world with a high quality of life (Mahizhnan, 1999). Currently, technology-driven projects supporting self-driving vehicles, smart housing, mobility and transport improvements are fairly prevalent and similar to Amsterdam, the focus on co-creation means there is an extraordinary number of these projects (Smart Nation Singapore, 2017).

With a focus on building economic, physical, social and environmental resilience in Wellington city, the Wellington City Council has a plan to become a ‘Smart Capital’ by 2040 (Wellington City Council, 2011). The Smart Capital has four distinct city goals for Wellington; people-

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centred city, connected city, eco-city, and dynamic central city. The City Council plans on future-proofing the city from imminent issues that will face the city, including economic downturn and climate change with the support of smart projects similar to those mentioned in the international examples above, and many the CCC is aiming to incorporate into their Smart City Project. The Wellington City Council aim to develop Wellington into the forefront of smart technology in New Zealand, using existing overseas evidence, and community consultation to develop specific projects to help achieve the previously mentioned city goals.

“Wellington as a smart city acknowledges our highly skilled, creative population; recognises how new technologies and innovations will help us to respond to future sustainability and resource challenges; and reflects a set of values that underpins much of what is distinctive about the city’s character.” (Wellington City Council, 2011, p. 9)

Wellington aims to utilise existing strengths of the city to further their smart city goals, using the existing knowledge of its people to influence the direction of smart development and connectivity of its people, places and ideas. Also, the city wishes to further the clean-green image of New Zealand, to proactively respond to climate change, and the future challenges associated with this, using the city’s existing natural assets to do so. Finally, the central city of Wellington is the main focus of the Smart Capital project, where the City Council will promote the area as a space of creativity, innovation and exploration. Utilising the existing assets of Wellington City is key to the success of the Smart Capital project, and a central focus for the City Council to achieve its four city goals. It considers people as the key driver of smart technology in the city, and central to the concept of a smart city;

“Wellington’s people are the city’s greatest asset. Wellington’s shape and character will continue to reflect the people who live in, work in, and visit the city. Wellington’s people-centred city will be healthy, vibrant, affordable and resilient, with a strong sense of identity and ‘place’ expressed through urban form, openness and accessibility for its current and future populations.” (Wellington City Council, 2011, p. 12)

Summing up these four smart city projects nationally and internationally, a significant of focus of these projects is on the user of the city, the communities, residents and visitors. This must be considered by the CCC’s Smart City Project. This research report will attempt to understand community perspectives in Christchurch, and suggest how to engage individuals in the Smart City Project, in similar ways to these four cities which are considered at the forefront of the smart city concept in the world (Audain, 2017; Buntz, 2016; Frearson, 2017; Garfield, 2017; Harper, 2017).

Internationally and throughout history definitions of smart cities have varied, and to further the ambiguity of the term “smart city”, academics have acknowledged a plethora of distinct types of cities similar to smart cities, including; wired cities, referring directly to cabling and connectivity in a city (Hollands, 2008); digital cities, web-based reproduction of cities, representing many different functions of a specific city digitally, open to non-experts through simplified GIS application (Couclelis, 2004); sustainable cities, cities that focuses on urban metabolism, issues like sewage, water, and waste management, and ways to use technology to improve the function of these issues and the overall sustainability of the city (Höjer & Wangel, 2014) (Batagan, 2011); green cities, one concerned with ‘greening’ all aspects of the city, including infrastructure, creating a low-carbon economy, managing flood and hazard risks, and attempting to mitigate the future effects of climate change (Antrobus, 2011); knowledge cities, Hayden Slaughter

one that focuses on locally grown innovation, creativity, and science, has a direct connection to the knowledge of its users, and one where physically and institutionally, it combines science with civic and residential functions (Yigitcanlar, O'Connor, & Westerman, 2008); and, other similar iterations of these (Cocchia, 2014). This research project will focus on smart cities specifically but acknowledges that these definitions blur the general understanding of the smart city further and highlight the need to define smart cities in the context of the city that it operates within, in the case of this thesis, this being Christchurch City. No one definition mentioned throughout this past section is an accurate representation of Christchurch's Smart City Project. In coming sections, a definition of Christchurch as a smart city will be discussed.

With these definitions in mind, Smart Cities in the context of Christchurch will be discussed, and an attempt to understand how these are defined within this context will be made.

3 The 'Smart City' in the context of Christchurch, New Zealand

The smart city in New Zealand is a new concept being discussed by local government and academics alike. Above, Wellington's Smart Capital example was discussed (Wellington City Council, 2011), which is the best example of a functional smart city project in New Zealand; however, The Christchurch City Council's Smart City Team is also currently developing smart projects and strategies to employ in Christchurch, improving technology and influencing innovation in the city, to achieve similar goals to those discussed in the above examples, including improving the function of city systems including waste management, disaster response and energy use, and increasing the level of community engagement in smart

technology and the city overall. To fully understand Christchurch's Smart City Project, this section will discuss the context of the city itself. The most predominant feature of the city's context is the 2010 and 2011 Christchurch earthquake sequence, which still has long-lasting effects on the city as a whole (Ministry for Culture and Heritage, 2017). The reason for this is to acknowledge the effect the earthquake events have had on the future development of the city, and the attitude of residents, assessed through the research process of this project. This will help to determine if this significant natural event will affect the development of smart city projects and if the types of projects implemented will differ from those in other examples of smart cities as discussed above, and will help to understand if smart city technology can support disaster recovery. The details of the Christchurch Earthquake sequence and its effect on the current design of the city will be discussed in the coming section, along with responses to the event and how they are contributing to the Christchurch's smart city prospects.

3.1 The 2010/2011 Christchurch Earthquake Sequence

Christchurch experienced a magnitude 7.1 earthquake followed by a magnitude 6.3 on the 4th of September 2010 and 22nd of February 2011 respectively (Ministry for Culture and Heritage, 2017). These two events and subsequent earthquake sequence have created a unique environment in Christchurch City. The second large event in 2011 event caused 185 deaths, thousands of injuries, disruption to the lives of residents, loss of industry and jobs, displacement, financial insecurity, loss of infrastructure, long-lasting mental and physical health issues for many, and many other negative effects both in the short and long-term (Usher-Pines, 2009) (Hogg, Kingham, Wilson, & Ardagh, 2016) (Dorahy & Kannis-Dymand, 2012). As well as these obvious effects, some groups like elderly populations and children, those with

disabilities or existing health conditions, and local community groups were unevenly affected by the earthquake sequence both immediately and during the seven years post-earthquake. This uneven effect is important to take into account when attempting to understand smart cities, as these too can have an uneven effect on similar groups.

An example of the uneven effect of the earthquake sequence, elderly populations experienced the effect of the earthquake event especially heavily, due to factors like existing health conditions and displacement from care facilities after the closure of 7 care facilities and the partial closure of 2 (Heppenstall, Wilkinson, Hanger, Dhanak, & Keeling, 2013). Issues like increased cognitive difficulties, increased anxiety and communication with elderly individuals caused difficulties for elderly populations and their carers immediately after the earthquakes. Although some studies have shown elderly populations as more resilient to the immediate effects of the earthquake sequence, in terms of depression and anxiety, the prevalence of existing health issues in elderly caused an un-proportionately bad response to the earthquake sequence from younger age groups (Heppenstall, Wilkinson, Hanger, Dhanak, & Keeling, 2013). Displacement also occurred for school-age children, of the 163 primary and secondary schools in Christchurch, most were closed for three weeks, 24 for longer than this, and 11 were set for permanent closure (Johnson & Ronan, 2014). 11,077 students transferred to another school entirely, and 8,458 of these transferred to schools outside of Christchurch. Again, this has been proven to cause or amplify mental health issues, post-traumatic stress disorder (PTSD) and other mental health issues (Johnson & Ronan, 2014) (Bateman & Danby, 2013).

The earthquake sequence exacerbated existing physical and mental health issues for a much larger demographic than just elderly and children, and caused many new health issues for many affected by the earthquake sequence. The sequence caused immediate physical injury to over
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1000 people after the 2010 earthquake, and 185 fatalities, 3129 injuries, and another 1293 injuries in the aftermath; however, the mental health issues caused were far more widespread and lasting (Bellamy, 2014). Research by the 'All Right?' in 2013 initiative found that more than 80% of respondents believed their lives to have changed significantly after the events, and many indicated they suffered financial difficulty due to the earthquake sequence. Research from The University of Otago indicated that individuals that suffered significant adversity from the earthquake sequence were twice as likely to be addicted to smoking, and 40% more likely to have mental health issues (University of Otago, 2014). Mental health, social stress and anxiety for the majority of majorly affected groups were typically exacerbated by the event, and displacement caused by the earthquake sequence, whether temporary or permanent, could both improve, if they feel more comfortable at their new location, or further exacerbate, if individuals reacted poorly to the move, existing and new mental health issues (Hogg, Kingham, Wilson, & Ardagh, 2016). This will be further discussed below in the discussion section, in relation to the earthquake sequence's effect on community and community groups in Christchurch. To fully understand the effect the earthquake sequence had on physical and mental health, and on those with existing disabilities (Ryan, 2015) a much more in-depth literature review would be required; however, this shows one group who has been unevenly affected by the earthquake events, helps to understand the context of the city post-disaster, and means that future planning of the city must consider these groups, and including when implementing new smart technology. Simply understanding the uneven effect the sequence had on different groups in society allows us to shape our understanding of smart cities in Christchurch, and this will be discussed further in coming section.

Community groups in Christchurch have been fairly prevalent in Christchurch through recent history, especially since the earthquake sequence (Berno, 2015). Along with the immediate
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disruption to the community in many areas, came an influx of new or revamped community groups, who used their community values to increase community resilience in areas of Christchurch (Gawith, 2011). Community responses from groups such as The Heathcote Village Project (Heathcote Village Project, n.d), and other neighbourhood groups drove resilience in their own communities, offering support for their community in the wake of the disaster, planning community events, small projects like community gardens and book fridges, and offering a number of other services like free tutoring, counselling and other classes. This support was integral for many individuals, families and communities coping with the effects of the earthquake sequence, as other support systems across the city were under an immense amount of pressure already (Gawith, 2011). The theme of community resilience has continued in Christchurch post-disaster, and in relation to the smart city could be utilised to help improve smart projects in the city. This will be discussed in more detail in coming sections.

3.2 Responses in a post-disaster environment

Christchurch's long-term response, seven years on from the initial event and earthquake sequence has influenced the cities design and use. Community resilience and new systems of governance (Bakema, Parra, McCann, Dalziel, & Saunders, 2017; Berno, 2015; Hayward, 2013), the redesigning or reimagining of the central city and its function through non-profit organisation (Carlton & Vallance, 2017; Hutton, Tobin, & Whiteford, 2016), and new technology (Marek, Campbell, & Bui, 2017) have all shaped post-disaster development in the city. These are integral in understanding Christchurch City in its current context, and how smart city technology can be implemented in the city.

3.2.1 *Community resilience and new forms of governance*

As discussed above, community organisations like The Heathcote Village Project (Heathcote Village Project, n.d) or the University of Canterbury Student Volunteer Army (SVA) (Hayward, 2013) in Christchurch played an integral part in the recovery process immediately and in the long term after the 2010 and 2011 earthquakes and subsequent earthquake sequence. Many of these groups still operate in Christchurch today and are continuing to promote community-based resilience in Christchurch seven years after the initial event. Resilience typically fails to support communities and is inadequate in incorporating community values, cultures, and other non-material goods into its planning and implementation. It is also typically too political, and decisions on resilience are made for affected people, rather than with them (Hayward, 2013). This is where strong community-based resilience has benefitted individual communities in Christchurch. Community or social resilience is local, it is by and for the people of an individual community, and incorporates a new sort of governance, led by the community and typically supported by a local government of council, although this is not always the case (Berno, 2015). Berno (2015) then discusses resilience as a socio-ecological systems approach, and defines this type of resilience as being encapsulated by four factors;

- (1) “learning to live with change and uncertainty;*
- (2) nurturing diversity (economic, biological and socio-cultural);*
- (3) adaptive knowledge for learning; and*
- (4) creating opportunities for self-organisation.” (Berno, 2015, p. 152).*

Community resilience is the coming together of a community in during a time of need, using these four factors to drive the process of resilience.

A number of organisations formed in Christchurch employing community resilience-focused strategies and these were key to immediate post-disaster responses, with communities coming together to support one another, where support from local governments and other agencies was under immense pressure. One example of community resilience post-disaster, although there are many and these are fairly diverse, is food resilience (Berno, 2015). The earthquake sequence caused food insecurity in many areas, cutting off main road networks for individuals and food supplies coming in, closed grocery stores and generally cut off access to fresh food and vegetables. This was a real problem immediately after the main event, but even seven years on there are still issues relating to access to food (Berno, 2015). Community resilience solutions to this issue created community gardens and food sharing schemes, both of which were seen in the Heathcote Community, and still operate (Heathcote Village Project, n.d). Community groups like this created their own independent style of governance, built on entrepreneurship, innovation and support. Acknowledging this as a key part of Christchurch residents' identities is key to understanding the context in which the Smart City Project is operating. This will be discussed in further detail in the discussion section of this thesis.

3.2.2 Redesigning and reimagining Christchurch City and its functions through non-profit organisations

Along with the 185 fatalities, and thousands of injuries, Christchurch city lost a large amount of infrastructure, business, and residential areas (Ministry for Culture and Heritage, 2017). Immediate issues like water shortages, damage to sewerage systems, road closures and liquefaction (Bouziou & O'Rourke, 2017) disrupted the lives of many, and the effects are still felt several years on. Around 80% of Central Business District buildings will have been demolished (Marek, Campbell, & Bui, 2017). Regardless of the overwhelming negative

consequences of the earthquake sequence, Christchurch has been offered a unique opportunity to develop a new urban layout for the central city and surrounding area. Like community resilience, many of the early stages of redevelopment, or temporary development (Carlton & Vallance, 2017), came from community responses, and innovation. Non-profit organisations like; Greening the Rubble, who create public green spaces and gathering areas for the people of Christchurch City, especially in unoccupied public and private areas in the city (Greening the Rubble, n.d); Gap Filler, an urban regeneration organisation with similar aims to Greening the Rubbles, creating typically short term projects to with recycled materials, green space, and other initiatives for use by the people of Christchurch (Gap Filler, n.d); and, the Re:Start mall, a container mall built on private land, and turned into a public space for shopping, eating, and relaxing (Re:Start, n.d). These temporary pieces of urbanism have contributed to the redevelopment of Christchurch, and some still have influence today.

Key here and the reason temporary urbanism is being touched on is that Christchurch's urban environment has predominantly comprised of temporary urbanism for the past seven years, and only now are new permanent structures and commercial areas starting to open in and around the city, with many new buildings still in development. This means Christchurch has a unique opportunity to utilise technology in its fundamental design and planning, and the CCC Smart City Project can achieve this. Working alongside non-profit organisations, and community groups and projects, like those listed above, will aid in increasing the usability and engagement with new technological projects in Christchurch (Marek, Campbell, & Bui, 2017) (Carlton & Vallance, 2017).

3.2.3 New technologies

The CCC Smart City Project is suggesting a number of new technological projects including SmartView, smart mobility parking and free Central Business District (CBD) Wifi. These will be discussed in the next section in more detail. There are, however, other technological projects that have been implemented already in the City, including the Sensing City projects, which has since closed, but attempted to gather data about the city through a series of sensors around the city (Marek, Campbell, & Bui, 2017). This project used these sensors around the city to monitor a number of factors, including water and air quality, and pedestrian and vehicle flow. The objectives of the project were;

“(1) to demonstrate the value of monitoring on a citywide scale, and in particular the value of citizen contribution and crowd sourced data;

(2) to show technology helping to understand the environment;

(3) to engage with citizens about the quality of waterways, and foster an environment where people not only contribute to information about their city, but as a result of being more informed, to take ownership of their environment.” - (Marek, Campbell, & Bui, 2017, p. 46).

The Sensing City project attempted to create a healthier environment in Christchurch, more efficient energy and water use, and provide more information for citizens about the environment in Christchurch (Christchurch City Council, 2016). Similarities between this project and the CCC’s Smart City Project are evident, both focusing on citizens and access to information about the city, doing this through the use of unique technology implemented in the city.

3.3 Smart Christchurch

Christchurch city is widely recognised by the 2010 and 2011 Christchurch earthquake sequence, and is characterised by its response to this major event through the formation of community groups fostering community resilience (Berno, 2015), the physical redesign of the city (Carlton & Vallance, 2017), and the new technology that is being, or has been implemented (Marek, Campbell, & Bui, 2017). The Christchurch City Council (CCC) Smart City Project is attempting to gain real-time data to understand how the city is functioning, and aid in better planning and decisions making within the city (Christchurch City Council, n.d). It has a variety of current technology focused projects attempting to achieve this, including SmartView, Bigbelly Solar Bins, and Sensibel, as well as many more projects in development, like CBD free Wifi and smart mobility parking.

3.3.1 Definition of 'smart Christchurch'

Before understanding the specific smart projects in Christchurch, the definition currently understood by the CCC and Smart City Project should be discussed. As mentioned above, the definition of a smart city is still being debated, and many organisations have developed their own understanding to fit the context their city. The CCC Smart City Project state on their website “We're exploring new technology and approaches to help make our city a smarter, safer place in which we live, work and play.” (Christchurch City Council, n.d). The CCC’s definition of smart city focuses on how technology can be used to gather data, improve the function of the city, and how it will support planning and decision making, attract international talent to the city, create new business opportunities, and design a city for everybody. A number of definitions listed in table one, two and from other cities smart projects should be

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acknowledged. The optimisation of city functions appears throughout literature definitions, discussing improving energy and water use, as well as public safety and mobility (Lazaroiu & Roscia, 2012). Kitchen (2014) mentions that smart city goals can be achieved through business-led initiatives and is informed by government decision making. And most reading indicated that smart cities are community orientated and driven, involving the city's users in the planning and implementation process of smart projects (Angelidou, 2015) (Kitchin, 2014), especially in the example of Amsterdam, where the majority of smart projects are community driven and implemented (Amsterdam Smart City, n.d). The CCC's project aims to incorporate these definitions into their smart city plan, with the support of this research project.

One aim of this research project is to pose a definition for the smart city in the context of Christchurch, created through interviews with stakeholders in the CCC's Smart City Project, and surveys and focus groups with citizens within Christchurch. The reasoning behind this is threefold, partly due to the lack of a current applicable definitions in research and internationally (Marek, Campbell, & Bui, 2017), the absence of one clear definition from the CCC Smart City Project and its website (Christchurch City Council, n.d), and the gap in current literature, where many definitions acknowledge the importance of incorporating community perspectives into smart projects, yet the definitions are far too complex and not applicable to the same people these projects aim to engage.

3.3.2 Smart projects in Christchurch

This project will focus on three of the CCC Smart City Project's smart initiatives, SmartView (Christchurch City Council, 2018), smart mobility parking, and CBD free Wifi. Of these currently only the Smart View project has been released in Beta to the public, however, a

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number of other smart projects, including Sensibel (Christchurch City Council, 2018) and Bigbelly Solar bins (Christchurch City Council, 2018) are in their trial stages.

Sensibel is a tool used to understand areas of a city where cyclists or public transport users have a good or a bad experience. A Sensibel is a physical attachment to the handlebars of a bicycle, or phone application for public transport users, which, if pressed once will record a good experience in an area, and if twice, a bad experience. This allows the CCC to visualise areas that cyclists or public transport users perceive as safe or enjoyable, or dangerous and bad. Used around the city, this could inform planning for future cycle and public transport infrastructure, as well offer real-time data and solutions to existing problems. The project is still in planning stages, however, Sensibel tool is currently being trialled by individuals in Christchurch. The project has three aims:

- (1) *“measure a commuter's experience of their bike, bus journey etc as they move into the city*
- (2) *highlight good and bad experiences so improvements can be made*
- (3) *provide feedback in a map to easily see where the best and worst commuter areas are.”*

(Christchurch City Council, 2018).

This project is focused on both improving the function of the city, and offering an easy platform for community participation in the city's design.

The Bigbelly Solar bins are rubbish bins with the purpose of helping to reduce the amount of waste in the city (Christchurch City Council, 2018). Two are currently installed in New Brighton, one for rubbish and one recycling, and are part of a trial to decide whether to implement these across Christchurch. They are equipped with a solar-powered compactor, that

compresses rubbish down to about one-sixth of the size. They also provide online alerts as to when the bins require emptying. The project aims to:

- (1) *“provide a solution to overflowing rubbish bins*
- (2) *reduce the scattered litter caused by the wind or seagulls*
- (3) *reduce complaints about overflowing rubbish bins.”* - (Christchurch City Council, 2018)

Since their implementation the CCC has listed a number of observations from the project; they have reduced the number of contractor visits; the Whale Pool area (a paddling pool for children that is well used by the local community) is tidier; fewer rodents and seagulls in the area; and, that much of the waste going into the recycling bins are not recyclable, rather is rubbish or food waste.

SmartView is a website application accessible via the CCC website (Christchurch City Council, 2018), and currently in its beta stage of development. It is a tool that shows real-time data about Christchurch city, to residents and visitors of the city. It shows information including cycle lanes, drinking fountain locations, public toilet locations, weather information, street art location and descriptions, bus network, flight times, current news, earthquake information, what's on around the city, and a variety of similar information. More information about this will be discussed in coming sections, however, it is important to consider this project in relation to similar projects internationally. City dashboards, similar to SmartView are a fairly new concept which has in many cases are aligned with the beginning of city's smart city programs (Gray, O'Brien, & Hügel, 2016). These use data gathered real-time to display information about the city, like SmartView, but more developed versions of this display far more detail. London's city dashboard shows in-depth current information about the city, including the number of available car and bike parking spots, the tubes line status, and traffic cameras in real time

(CASA, n.d), however, this too is an early prototype. The CCC's Smart City Project has an opportunity to build SmartView into the forefront of City Dashboard technology internationally.

4 What does this mean?

This chapter has discussed; the conflicting definitions of 'smart cities' and how these are divided between academics, businesses and governments; it has mentioned four key cities pursuing smart city technology, Barcelona, Amsterdam, Singapore and Wellington; discussed smart cities in the context of Christchurch including the 2010 and 2011 earthquake sequence responses to this; and, finally a discussion on smart city projects in Christchurch.

The key points from this chapter are; that firstly, the smart city is a new concept and its definition is still widely debated among academics, businesses and governments. Secondly, the concept of the smart city must be redefined in relation to Christchurch, taking into account the context of the city including the effects of the 2010 and 2011 earthquake sequence, community resilience, and the redesign of the city, and community resilience and its effect on the recovery of the city. Third, community participation is key to a successful smart project, which is clear from the examples in Amsterdam, Singapore, Barcelona and Wellington, as well as many definitions through academic literature.

This chapter has discussed international examples of smart cities and offered examples that will be taken into the next stages of research in this project. Moving forward, this literature

review has been used to inform the methodology of the research project and this will be discussed in the coming chapter in more detail.

Chapter 3: Methodology

1 Introduction

This research has used participatory research to understand community perceptions of the CCC Smart City Project, and how to engage citizens in the project going forward. Participatory research, in the case of this project, is research that attempts to engage citizens to an extent where they become willing participants in future research and agents of change themselves, not merely consultation but influencing a high level of engagement and interest in the project itself (Pain & Francis, 2003). Participatory research requires democracy between the agencies in the project, in the CCC Smart City Project, this is citizens, the CCC and other stakeholders like businesses, and should foster a willingness in participants to engage on for their own interest (Bergold & Thomas, 2012). The research of this project is broken into four main sections, the review of existing smart city literature in Chapter two, and stakeholder interviews with individuals at the Christchurch City Council (CCC) involved in the planning of the CCC Smart City Project, either in the team itself, or involved in broader urban planning in the city. A community survey and community focus groups were conducted. These have provided the qualitative and quantitative information about community perspectives of the Smart City Project and smart technology, to address the aim of this research project, to suggest ways to create actionable and meaningful data for residents and visitors in the city from the information gathered in Christchurch's Smart City Project, and provide the CCC Smart City Project with data to improve existing projects, create new ones, and offer insight how to make the data meaningful, engaging the users of Christchurch city in the process of becoming a smart city. The methods of research employed in this project have been discussed by Iain Hay (2005), in his book *Qualitative Research Methods in Human Geography*, and this has provided background into the methods used in this thesis project. In part two of his book, the purpose

and structure of interviewing (Dunn, 2010), focus groups (Cameron, 2010) and questionnaires (McGuirk & O'Neill, 2010) are discussed. These methods have been used in this project, through a stakeholder survey of four CCC employees, a community survey, and two community orientated focus groups. The following section will discuss the reasons for the use of these three research methods. It will first outline the research process, before discussing the research process itself. As well, it will justify why this form of participatory research has been used to assess community perceptions of the CCC Smart City Project (Darnall & Jolley, 2004). Finally, a description of data analysis process will be offered, leading to the results chapter of this research.

2 Background to methodology and community engagement

As mentioned in the introduction, this research aims to offer solutions to increase engagement in the CCC Smart City Project, through community-focused participatory research. This section will justify why this type of research has been utilised, through an analysis of research methods from smart cities internationally, discussed in the literature, a description of participatory research, and this will be related back to the context of Christchurch, with specific emphases on community resilience in the city.

2.1 International examples of smart city planning from literature

Amsterdam's Smart City (ASC) (Amsterdam Smart City, n.d) and Singapore Smart Nation or Intelligent Island project (Mahizhnan, 1999) both express the value of community focused and participatory design in their smart city projects (Smart Nation Singapore, 2017). These two

smart projects are both credited as being important and successful smart cities in the world (Buntz, 2016; Frearson, 2017; Harper, 2017), and it is important to understand the processes taken to achieve this high standard of a smart city. Much of this success can be attributed to the open sourced nature of their smart projects, as mentioned above, incorporating community perspectives directly into their smart projects through engagement in all stages of the development of smart technology. Open sourced, in this case, referring to access to data gathered from smart cities, and the smart projects in the city, as individuals are encouraged to create their own smart city initiatives to benefit themselves and the city. Incorporating similar strategies as these examples, to understand community perspectives of the CCC Smart City Project and engage communities further in smart projects will inevitably increase engagement in the projects themselves (Snow, Håkonsson, & Obel, 2016). In Aarhus, Denmark, the success of their smart project relies on the collaboration between ‘actors’, being citizens, firms, knowledge institutions and leaders, these actors share the responsibility and desire to transform the city with smart technology (Snow, Håkonsson, & Obel, 2016). Key to Aarhus’s smart city, is the use of open-sourced data, gathered from these four different groups, and using participatory research, this project will attempt to understand if similar open-sourced, and participatory focused strategy will be appropriate in increasing engagement in the CCC Smart City Project.

In order to understand how to assess community perceptions of the CCC Smart City Project, the research in this thesis project has used participatory focused research, which will be fully defined and justified in section 2.2 of this chapter, which in turn will raise awareness of the Smart City Project, and attempt to engage communities in the project as suggested in the case of Amsterdam, Barcelona and Aarhus (Amsterdam Smart City, n.d) (Mahizhnan, 1999) (Snow, Håkonsson, & Obel, 2016). Very few studies assessing community perspectives on smart city

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projects have suggested ways in which to achieve increasing engagement and participation from citizens broadly, however, as mentioned many times throughout this research, the majority of smart city projects consider the citizen, or the user of the city, as a predominant stakeholder in the success of smart cities, and a group that can drive smart projects (Eteszadzadeh, 2016; IBM, 2013; Marek, Campbell, & Bui, 2017; Snow, Håkansson, & Obel, 2016). This is a key research gap acknowledged in this project and will be developed upon further in the coming chapters.

2.2 Participatory research

As mentioned in this section, this project used participatory research methods to support the results discussed in the current literature on smart cities and answer the aim; to suggest ways to create actionable and meaningful data for residents and visitors in the city from the information gathered in Christchurch's Smart City Project. Participatory, in this case, means qualitative research focusing on the participants, how to engage them in further stages of the research, beyond just the initial research phase, and using these results as a driver for change, with respect to the communities wants and needs (Bergold & Thomas, 2012; Pain & Francis, 2003). It is research that requires co-operation between the research and participant, and other involved organisations (Kendon, 2005). With this in mind, this specific research project, rather than conduct follow-on research to increase individual's participation and engagement with the overall CCC Smart City Project will suggest ways in which the CCC should best achieve this going forward. Interviews, a survey and focus groups with the users of Christchurch City were used as a platform to increase participation in the Smart City Project, to increase the initial awareness of the project and smart cities in Christchurch, and understand what projects would

be best to increase participation with the CCC Smart City Project. These methods were employed due to the ability to compare results between the three methods by using qualitative information gathered through the survey to shape questions and the discussion in the focus groups, and surveys can reach a large audience in a short time, and focus groups a smaller audience with far more detail (Bradshaw & Stratford, 2010; Cameron, 2010; McGuirk & O'Neill, 2010). There has been criticism of these three methods as forms of participatory research, where there is a shortage of technical data relating to the issue at hand given to participants (Darnall & Jolley, 2004), in the case of the CCC's project, few participants knew of smart cities and were offered a brief introduction at the beginning of the survey or focus group; however, as there is little evidence discussing how best to consult communities on smart cities to increase engagement, these methods were seen fit to address the aim and provide an initial assessment of community perceptions. The effectiveness of this participatory research, in this case, will be assessed upon the completion of the research, and suggestions will be made for the CCC and future national and international smart city projects to use participatory research effectively.

2.3 Engaging communities in Christchurch

Communities and community groups are key to both smart cities internationally, and Christchurch City in a post-earthquake environment (Hayward, 2013). The value of engaging community groups in smart city projects has already been discussed both in relation to Christchurch in section 3.2 of the Literature Review chapter and in section 2.1 of this chapter where international smart cities with high community engagement contributing the success of their smart cities have been acknowledged. This is specifically important in post-earthquake

Christchurch, where community groups have been a significant driver of recovery over the past seven years. Rather than attempt to engage all communities, this research project aims to target the users, residents and visitors, of Christchurch City more broadly, and from this suggest ways in which to target community groups more specifically in the CCC Smart City Project. Relating to participatory research as discussed in the previous section, as participatory research methods are effective in engaging existing community groups like The Heathcote Village Project (Heathcote Village Project, n.d) and Student Volunteer Army (Hayward, 2013). Each of the three research methods used in this project engages the users of the city in the CCC Smart City Project and consider how best to further engage communities in the Smart City Project. This will be discussed in further detail in the next three chapters.

3 Research process

As mentioned, this research involved four methods of research, a literature review which has been discussed, and stakeholder interviews with individuals within the CCC, a community survey, and focus groups.

3.1 Stakeholder interviews

Stakeholder interviews were conducted in order to understand the Smart City Project, future plans, the current smart projects implemented or being planned, and the CCC's definition of a smart city in the context of this project. These interviews were also used to structure the subsequent survey and focus groups. Sections two through five of the interviews (shown in appendix one) highlighted a number of key points that will be discussed in the Results and

Discussion sections. The data gathered from these interviews will be used to a) understand the current context of the CCC Smart City Project, b) define smart cities in the context of Christchurch, and c) offer suggestions to the CCC to increase citizen engagement from the Smart City Project based on their current engagement techniques.

Four interviews were conducted, two with individuals with direct input in the Smart City Project, and two with individuals involved in urban planning within the city and with a general interest in the project. A series of questions were asked, appendix 1 shows the question matrix used in each interview. These were developed with input from The CCC Smart City Project and through reviewing the literature, with the aim to assess whether the CCC's project aligns with those in international examples and the literature.

The interview was broken into five sections, each with a specific aim, with focus on the interviewee's role in the CCC Smart City Project, and understanding of smart cities as a concept. Firstly, an introduction section, explaining the details of the interview to participants. Second, questions were asked to understand the role of the individual in the CCC and in the Smart City project. These served as an indication for the researcher of the overall involvement of each interviewee in the Smart City Project. Third, questions specific to the Smart City Project were asked, to understand the objective and outcomes of the project, including overall goals, perceived or encountered barriers, considered measures of success, and the projects overall usefulness to Christchurch. Fourth, the interviewee was questioned on their perspective of smart cities as a concept. They were asked to define smart cities in their own words to understand if this aligns with governmental definitions internationally, as discussed in section 2.2 of the Literature Review chapter, and questioned about what the CCC Smart City Project

is doing currently, what specific projects were being trailed to their knowledge, and what other

projects were being planned. Following this they were asked a number of questions about citizen engagement in smart city projects, including how to engage citizens, which groups to target, the value of engagement in this project, how to improve engagement through the Smart City Project, and how they thought this could or would influence behaviour change in users of Christchurch city. Finally, respondents were asked their opinion on how best to answer the aim and objectives stated in relation to their understanding of smart cities and the Smart City Project. This was to understand how individuals in the project perceive participation and engagement currently and would attempt to engage citizens in the project currently.

3.2 Survey

After consulting CCC stakeholders of the Smart City Project, a survey was developed to begin the participatory aspect of this thesis report. This was structured to understand the perspectives of the users of the city in relation to smart cities and assess what type of engagement techniques would increase participation in the Smart City Project, and what smart technology in the city would be of interest to the users of the city. This community survey was designed and conducted within Christchurch electronically. The survey was active for one month, from the 20th of November until the 20th of December 2017. It was created on Qualtrics (Qualtrics, 2005) and distributed electronically via email and social media (Facebook). It was circulated through neighbourhood pages, the UCSA (University of Canterbury Students Association) and PGSA (Post-graduate Students Association) Noticeboards, two student community group, through professional networks and email connections of council members, and three personal Facebook accounts. The neighbourhood groups surveyed were Beckenham Neighbourhood (3776 members), Hoon Hay Neighbourhood (1665 members), Hornby Neighbourhood Watch (1179

members), and Cashmere Neighbourhood (377 members). The UCSA Noticeboard (13,078 members) and the PGSA Noticeboard (557 members) are both student-focused community groups, offering a platform to reach younger generations, where the other community groups did not. The survey was also distributed to a number of businesses in the technology and innovation sector in Christchurch; however, this was not particularly effective as the engagement levels were too low to provide substantial data, this will be discussed in the limitations section of this report.

Respondents were given detailed descriptions of the concepts discussed in the survey, including smart cities, city dashboards, and other ideas for new projects in the city. They were given the opportunity to pull out from the survey at any point by closing the browser. Once finished, however, they could not remove their response. The survey was completely confidential. The respondents were offered the opportunity to include personal details in a separate survey if they wished to participate in a focus group on the smart city project. This will be discussed in the next section.

The total number of respondents to the survey was 187; however, 75 of these were incomplete, so 112 complete survey responses will be analysed in this research. The implications of this will be discussed in the limitations section of this project. There are issues of bias here, where respondents represent individuals already engaged in community groups. This issues will be discussed further also, in the limitations section.

The survey questions are attached in Appendix 2. These were developed after conducting the stakeholder interviews, understanding the smart city in relation to the CCC's project, and attempting to understand community perception on specific smart projects in Christchurch,

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Similar to the interviews, this has been separated into seven sections, excluding the introduction and consent sections. First, General questions about the respondents use of Christchurch City, including transport mode and access to information. This highlighted information to understand each participant of the survey, based on their usual transport method, their residential status in Christchurch, and their main form of access to information about the city and how this could be improved for them, to understand why participants might want specific projects in the city. If they answered that they were a Christchurch resident, they were asked for their suburb details, in order to map individual's home suburbs to understand if this related to their perspectives on smart cities, however, due to a number of complications with the data this was not analysed, to be discussed later in the limitations section.

The subsequent second, third and fourth sections asked questions about the three specific smart city projects focused on in this research project, and being trailed and implemented in Christchurch City. These being CBD Wifi, SmartView and smart mobility parking. These were chosen as they have a direct impact on the targeted stakeholders, the users, and are projects being trialled currently, or are planned to be implemented in the near future. The questions asked assessed to what extent individuals would engage with each of these projects, and how they would be inclined to access information about them, to understand if participants saw value in these projects, would be likely to engage with them in some way and if they would affect behaviour change in the city. More specific questions were asked about mobility parking, to individuals who had experience, or knew someone with experience using these in Christchurch. They were asked the extent they, or someone they knew, used mobility parking in Christchurch, if current mobility parking provisions are adequate for their needs, for suggestions to improve current mobility parking and access to this in Christchurch, and if they

would use an application that displays information about mobility parking, allows comments

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on these parks to be made, and reports information about this directly to the CCC. These three sections aid in understanding surface level opinions of citizens, on the three smart projects being focused on in this research. This allows the CCC Smart City Project to improve these projects and increase their usability for citizens, understand what would influence participation in these projects, and how best to engage citizens in projects being trialled, or planned for implementation.

The next section asked individuals about new smart projects in the city. It asked, what new projects respondents would like to see coming from the CCC Smart City Project, how they, in their own words, would describe what a 'smart Christchurch' would look like, their concerns and worries about smart cities and The Smart City Project, and for a ranking of the six strategic goals of the CCC Smart City Project from most important to them, to the least important. The information gathered is used to provide recommendations to the CCC to reduce the issues of smart cities perceived by citizens, and to offer a number of new project ideas for the future stages of The Smart City Project. Also, as mentioned, respondents were asked to rate the six strategic goals of the Smart City Project in order of importance to themselves. These six goals are; Enabling active citizenship and connected communities; Maximising opportunities to develop a vibrant, prosperous and sustainable 21st century city; Climate change leadership; Informed and proactive approaches to natural hazard risks; Increasing active, public and shared transport opportunities and use; And, safe and sustainable water supply and improved waterways. Each of these can be achieved through the implementation of new smart projects and technology in Christchurch, so understanding which citizens believe to be of more importance will help the project focus first on specific technologies and their implementation in the city that aim to achieve these goals. This is an important point to understand community

perspectives of The Smart City Project and will be discussed in more detail in the coming sections.

Finally, the participants were asked for some demographic details. This was for the same reason as the general information in the first section, to understand basic details about the respondent. They were asked for their gender, age, ethnicity, and their highest level of education. Each will be analysed in relation to previous answers, to understand the effect of demographics on engagement with smart projects and technology. This is important, as discussed in the literature review, as individuals in a variety of demographic situations have different needs in the city, and the Smart City Project must address what these are. All groups must be represented for the project to be successful.

3.3 Focus groups

The final stage of research involved two focus groups. Each focus group was made up of six people. These were run on the 21st and the 23rd of March 2018. Participants signed agreements to remain confidential in the research and were offered the opportunity remove their response after the completion of the sessions. The focus groups were also broken into key sections, aligning with the survey to allow more in-depth detail and explanation to support the data gathered from the survey. These questions help to answer how to engage communities in The CCC Smart City Project, and how to influence behaviour change within citizens in Christchurch.

First, participants were asked general questions about the concept of smart cities. The majority of participants had no experience with the concept, although some had heard of examples of smart projects in the city, so a description of the concept of the smart city was offered, and some relevant context about The CCC Smart City Project was discussed. This was used to frame the first questions, asking in the participants own words, how they would describe a 'smart Christchurch'. Participants were then asked how they gather information about the city, and how this could be improved for Christchurch. These helped to understand the level of knowledge of participants and will aid in redefining smart cities in the context of Christchurch in coming sections.

Second, the three current smart projects being implemented in Christchurch, CBD Wifi, SmartView, and smart mobility parking, were discussed. Similar to the survey, participants were questioned to understand if they would use these projects, to what extent they would, issues they perceive in, and how they would improve or change these to mitigate these issues and best suit their own needs. Again, the questions relating to mobility parking were focused on those with experience or who know of other with experience using these in Christchurch, however, unlike the surveys, these questions were not limited to just this group, and those without experience offered their opinions also. From the answers and discussion created by these questions, the reasons behind individual's perspectives on these projects could be better understood and similarities between these answers and those in the survey.

The final section asked about new smart project and their implementation in Christchurch. Individuals were invited to discuss new projects they think would benefit them and Christchurch as a whole, which groups in the city should be targeted, how they would like to access information about new projects and The Smart City Project overall, and how best to

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consult communities and citizens in Christchurch in the future planning of the CCC's Project. Once again, relating this back to the answers given in the survey from similar questions will elaborate on the reasoning for these opinions, which will be discussed further shortly in the Discussion chapter.

4 Analysis

The data has been analysed through the use of NVivo (QSR International, 2016) for qualitative analysis of survey data, Microsoft Excel for quantitative data analysis, and summary transcriptions of both the interviews and focus groups. The method of analysis will be

Appendix one shows the question matrix for the stakeholder interviews. The data analysis of answers was broken into sections, relating to specific questions that were asked. These sections aim to answer the objectives of this thesis report, in section two of chapter one. Information from all four interviews was broken into their key points for further analysis and comparison of survey and focus group information.

The survey generated both quantitative and qualitative data, through closed and open-ended questions, shown in appendix two. The quantitative data was exported from Qualtrics to CSV and analysed in Microsoft Excel. Counts of respondent's answers were simplified into tables and graphs to show general trends, including demographic information about who responded to the survey, and perceptions of The CCC Smart City Project. The data from these were compared to assess if the demographic information had an effect on respondent's understanding and opinions around the smart city in Excel. This data was compiled into

sections, which will be discussed in the results chapter of this thesis report. Each section related to part of the research, including the three specific smart projects assessed, SmartView, smart mobility parking, and CBD free Wifi, new projects, demographic information, and a number of other sections. They have each contributed to answering one of the research objectives stated in section two of chapter one.

The results from the two focus groups were analysed similarly to the stakeholder interviews, breaking the discussion into its key points and relating these back to the objectives of the thesis project. These were summarised into key points for comparison with the results of the survey and interviews. The results gained from the stakeholder interviews, community survey, and focus groups, will be discussed in relation to each other, and the key points raised through the literature review process in the coming results chapter.

Chapter 4: Results

1 Stakeholder interviews

As part of the methodology of this thesis project, and to inform the next stages of research, four stakeholder interviews were conducted to build an understanding of the current state of the Christchurch City Council's (CCC) Smart Cities Program. These were with employees of the CCC who have input in the project currently, and an understanding of different parts of the Smart City Project. These interviews took place between the date of the 19th of July and the 24th of August.

The main purpose of these interviews was to develop the researchers' own understanding of the project and provide insight into which projects will influence behaviour change in residents in Christchurch. With this in mind, the interview matrix in appendix one was developed. The questions relating to the individual's role at the CCC and in the Smart City Project, project outcomes and challenges, smart cities as a concept, citizen engagement, and suggestions for this thesis project. The following discussion highlights the key points gained through the interview process. Each interviewee is labelled from I01 to I04, in relation to the date the interview took place (I01 id the first interview and I04 is the last). In this research, the CCC has been understood as a governmental organisation, to align with Rob Kitchin's (2015) smart city definition relating to governments, being "They are producing technologies and ideas that will create economic growth or improve governance." From here this research will understand how the interviewees would define smart cities. The following is an account of the key points from the interviews relevant to the methodology of the research.

1.1 Outcomes and challenges

The interviewees ranged from managerial and operational positions directly involved in the Smart City Project to roles peripheral to the project with a vested interest in smart city technology or the operation and implementation of the projects in Christchurch. This provided a diverse range of viewpoints of the project, and a depth of knowledge to aid in understanding the project.

At the time of interviews, 16 unique projects were in planning or development stages. Three of these were the focus of this research, SmartView, smart mobility parking, and CBD free Wifi, although the individuals interviewed had knowledge of other projects so discussed these also. They are discussed in more detail further in this results section and in the Discussion chapter. A variety of outcomes were discussed.

I01 mentioned the Smart Cities Project aiming to provide “proof of concepts” for the suggested projects. They discussed the goal of the project is to trial new technologies at small scales, which will be implemented city-wide if proven successful. An example raised is the Bigbelly Solar Bins in New Brighton. If these prove effective in helping to reduce the amount of overflowing rubbish in New Brighton, then they will be implemented in other parts of Christchurch. It was acknowledged in the interview that some projects will fail, meaning they will not be implemented in the city. This allows the Smart City Project to trial multiple projects without having to guarantee their success initially, and they have the opportunity to fix issues that arise in the projects before being implemented city-wide. Christchurch, therefore, aims to become a leader in many aspects of smart city projects worldwide. Some challenges that I01

highlighted included; a lack of funding for new projects and initiatives from the CCC, as it is not currently a long-term project; issues getting citizens to engage in the projects due to a fear of change and new technologies; and, the concept of smart cities must be inclusive of the entire population, which can be challenging as many projects only target specific groups in society. I01 considers increasing engagement with the projects a key indicator of the success of the projects.

I02 discussed the Smart City Project as a method for education and introducing new technologies that may seem ‘scary’ to residents in Christchurch City. Some key outcomes of the project being; changing mindsets on new technology in the city; increasing the level of innovation, specifically for new technological projects; and breaking down barriers between the CCC and residents in the city, through the use of crowd-sourced data in decision making. I02 saw the Smart City Project having benefit for society in Christchurch through due to a number of factors integral to the success of the project. They discussed how the project can and aims to increase engagement in communities, promote participatory democracy in decision making, foster citizen empowerment and allow all citizens to ‘have a voice’ across the city and promote diversity by being inclusive of all citizens. They discussed barriers to the success of the project including; defining the term ‘smart city’; resistance to change and new initiatives from the council itself; and, the potential of future challenges if the smart city projects begin to become privatised.

I03 was not directly involved in the Smart City Project; however, does oversee the process. With this in mind, they discussed the project as attempting to ‘find new ways to do things’, or more specifically, new ways to improve the function of the city. It is a project that cannot afford to be complacent about anything, it must always strive to improve existing projects and be

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innovative with new ideas. They saw few issues with the project in its current state, stating it is very well set up. They also mentioned they saw few issues with the budget of the project. Key to the success of the project, I03 highlighted that they would see the projects being used by people in Christchurch, although some of these are hard to measure. They also reiterated, like I01, that the failure of some projects is fine, for similar reasons to above.

The final interview, I04 also is not directly involved in the project. They mentioned the Smart City Project as being integral in inspiring people of the possibilities of smart city technology. They highlighted three key steps of success; 1) Trialling, the ability to trial new initiatives before implementation; 2) Failing fast, meaning the projects can fail quickly, and be fixed or replaced with other new projects; 3) Operationalising project, the ability to operationalise the smart city projects into the whole city once they have been proven successful. The main challenges discussed were similar to that already mentioned. These included; the difficulty operationalising these projects, and who will oversee the monitoring and maintenance of the projects; and the cost of the projects for the city, and whose responsibility this will be.

1.2 Smart city as a concept and citizen engagement

The interviewees were asked to define the term smart city and what this meant to them, and other questions relating to the extent of citizen engagement in the project currently, and how this could be improved in the Smart City Project.

I01 discussed their definition of smart cities, "...using current technology and approaches to answer today's problems". They mentioned this being important because current functions of

the city, including sewage, road systems and other infrastructure still being based on early 20th century designs. This definition sees the smart city as a solution to issues in cities, but also a way to improve the overall function of the city. They acknowledged the need for community engagement in the planning process of the Smart City project and mentioned that due to the project still in planning stages, this is yet to come to fruition. Further on citizen engagement, they offered ideas of how to approach this, including; focusing on understanding what is currently understood by individuals, or not; interest levels in proposed projects, and what would influence them to engage with these projects; how to go about engaging individuals in the planning and implementation processes; and what fears do they face with these smart projects, and the smart city project as a whole? I01 suggested generally under-engaged individuals as the target demographic, including younger generations, older generations, lower socioeconomic groups, minority ethnicities, and other groups typically less engaged in City Council led consultation. I01 reiterated that this engagement in the project is a key indicator of the success of the Smart City Project as a whole.

I02's definition of smart cities was, "For me, a smart city, first of all, should be inclusive like I said, it should cover every group the city has... a smart city is all about making life a lot easier for its citizens and residents". They mentioned that the Smart City Project is not about improving the function of the City Council, it is about doing something for the city and all of its residents and visitors, to help them feel safe. "...smart cities are not about technology, the technology is an enabler, but it's not all about technology. It's also about, you know social, getting people involved". This definition focused on people as a key element in smart cities, which aligns with the outcomes I02 outlined above. In relation to citizen engagement, I02 reinforced some of the points made by I01. They mentioned how the project is still fairly new, and citizen engagement will be considered for the next stage of the project. This will come in

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media releases and engagement with community boards. Again, they mentioned elderly and younger age brackets as key in this consultation period, to ensure inclusiveness of the project.

When questioned about their definition of a smart city, I03 said “... at the very broadest level, I would define a smart city as one that uses the incredible talent of the people who live in the city.” This definition puts people not just as the consumer of the smart city, but the creator. They mention that if individuals within a city are excited or invigorated about something, they are more likely to be involved or engage with that thing, and are more likely to be involved in creating and innovating in the city. The consumer of the smart city can be the creator. This lends itself well to the idea that smart city technology requires strong citizen engagement and crowdsourcing can support the projects immensely, and this will be discussed further in the coming chapters. I03 goes on to discuss participation in the project budgeting and planning to integral in ensuring citizens are engaged and maintain a vested interest in the project, and this must be easy and accessible to all.

Finally, I04 “I guess I see smart cities as, taking on board and leveraging off new technologies, and ways of doing things that will, through the use of technology... ultimately benefit the citizens”. This definition, once again considers citizens a key aspect of what makes a smart city smart. “... and that could be through more efficient working as The Council, it could be through better services.” Aligning with the argument for the importance of citizen engagement in the Smart City Project, this definition is similar to those mentioned previously. Although I04 did not offer any suggestions regarding citizen engagement, the definition offered makes it clear this a key element of smart cities.

1.3 Summation of key points and further research.

A few clear points reoccurred throughout the four interviews conducted. These being; the Smart City Project is trialling projects that, if successful, will be implemented city wide, meaning the project can fail, and this is encouraged; main issues raised with projects currently are, the long term funding opportunities for projects, and the fear of some projects that citizens may experience, caused by security risks and change generally; participation in all projects is key to the success of the Smart City Project; the projects must be inclusive of all in the city, including citizens and businesses; and the definition of smart cities must include citizens as the key indicator of success. These points will be developed on further in the discussion chapter next, in relation to the survey results and focus group discussions.

This research aims to develop on these points, taking suggestions from the interview process into the next stages of the methodology. The key points discussed above have been considered in the development of the survey and focus groups. Further, differences between The Christchurch City Councils views of smart cities, and that of citizens in Christchurch will be acknowledged. This will attempt to address the issues mentioned by the interviewees above and answer the research question.

2 Survey

The survey in this research has engaged citizens in Christchurch, was active for one month, from the 20th of November until the 20th of December 2017, and was created on Qualtrics (Qualtrics, 2005) and distributed electronically via email and social media (Facebook). It asked questions about citizen's use of Christchurch City, how individuals access information about the city, demographic data, respondent's perspectives on smart cities and specific smart projects, SmartView, smart mobility parking and Central Business District (CBD) Wifi, and other information that answers the aim of this research. It was circulated through neighbourhood pages, the UCSA (University of Canterbury Students Association) and PGSA (Post-graduate Students Association) Noticeboards, two student community group, through professional networks and email connections of council members, and three personal Facebook accounts. The results from the survey questions, attached in appendix two, are highlighted below. This includes information to answer the aims of this research highlighted in section two of chapter one.

2.1 Demographic

Respondents were asked a number of demographic-based questions. They were asked gender, age, ethnicity, and the highest level of education. Table three through six show the results.

Table 3: Gender of respondents

Gender	Count	Percentage
Female	79	70.5%
Male	31	27.7%
Other	2	1.8%
Grand Total	112	100.0%

Table 4: Age of respondent

Age	Count	Percentage
18 - 24	67	59.8%
25 - 34	15	13.4%
35 - 44	14	12.5%
45 - 54	8	7.1%
55 - 64	4	3.6%
65 - 74	3	2.7%
75 - 84	1	0.9%
Grand Total	112	100.0%

Table 5: Ethnicity of respondents.

Ethnicity	Count	Percentage
European	91	81.3%
Asian	8	7.1%
Māori	6	5.4%
Middle Eastern, Latin American, African	2	1.8%
Pacifica Peoples	0	0%
Other	5	4.5%
Grand Total	112	100.0%

Table 6: Highest level of education of respondents.

Highest Qualification	Count	Percentage
Bachelors degree or level 7 certificate	36	32.1%
Level 1, 2, or 3 certificate eg. NCEA level 1,2, or 3	29	25.9%
Honours or post-graduate degree	21	18.8%
Masters degree	13	11.6%
Level 4 certificate eg. apprenticeship	4	3.6%
Level 5 or 6 certificate eg. advanced trade cert	4	3.6%
PhD Doctorate	3	2.7%
No qualifications	1	0.9%
Overseas secondary school qualification	1	0.9%
Grand Total	112	100%

Table three shows a much larger proportion of females completed the survey, 71% female, 28% male and 2% that specified other. This could be due to a number of reasons, that females are more likely to be involved in neighbourhood pages or on Facebook, or they have more interest in smart city technology. This is just speculation, however, but it is important to note the much higher number of females participating in this survey.

Table four indicates there was a much larger number of younger participants (60% in the 18-24 category, and 13% in the 25-34 category). This could be due to the good reception the survey received on the UCSA noticeboard. This could also be due to younger generations engaging more with technology in the city. 27% respondents were between 35 and 84 years of age.

There were vastly more European respondents (81%) than other ethnicities. There were 7.1% Asian, 5.4% Māori, and 4.5% Middle Eastern, Latin American or African. 1.8% respondents also identified as other. No respondents identified as Pacific Peoples. This is shown in Table five.

Finally, Table six shows the largest proportion of respondents currently hold a bachelors degree or level 7 certificate (32.%) followed by NCEA level 1 through 3 (26%), then honours or post-graduate degree (19%). The majority of respondents hold a Tertiary level degree.

These details will be discussed further in coming sections, comparing demographics with perspectives on smart city technology, new projects and transportation.

2.2 Access to information and location

Respondents were asked if they were Christchurch residents, and if they answered yes, they were asked which suburb they are from. Table seven below shows the majority of respondents are residents of Christchurch (94%) and a small proportion (5.4%) were not. Those that responded as Christchurch residents will be mapped based on their suburb in the final thesis report.

Table 7: Are the respondents Christchurch residents.

Christchurch Resident	Count	Percentage
Yes	105	93.8%
No	6	5.4%
Other	1	0.9%
Grand Total	112	100.0%

Respondents were then asked about how they access information about Christchurch city and if this could be improved for them. Figure one shows respondents main form of accessing information about Christchurch city, with 46% of respondents indicating they predominantly use Social Media, and 34% using the internet.

Figure two then shows what other methods respondents use to access information about the city. Once again, Internet and Social Media were the most common, at near 90%, and word of mouth third most common, with around 70%. Few respondents use the Christchurch City Council website as their main way to access information about Christchurch (4%) but around 40% indicated it as another way they access information about the city.

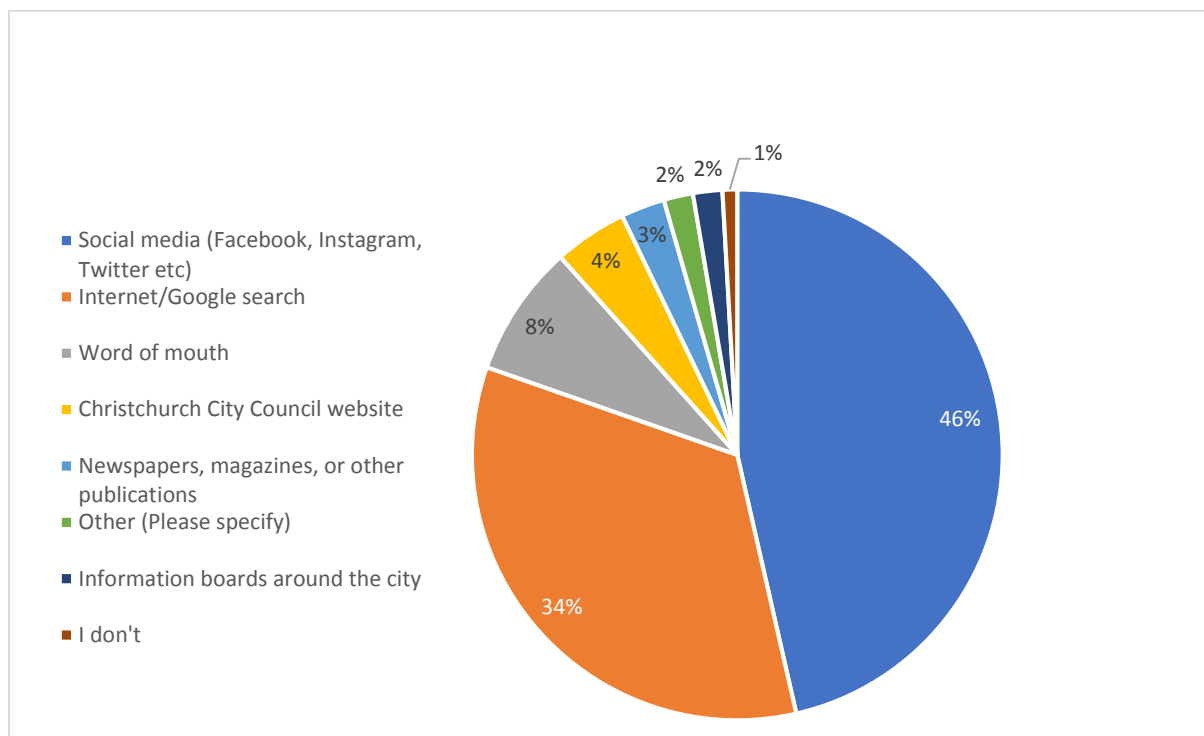


Figure 1: Respondents main form of accessing information about Christchurch city.

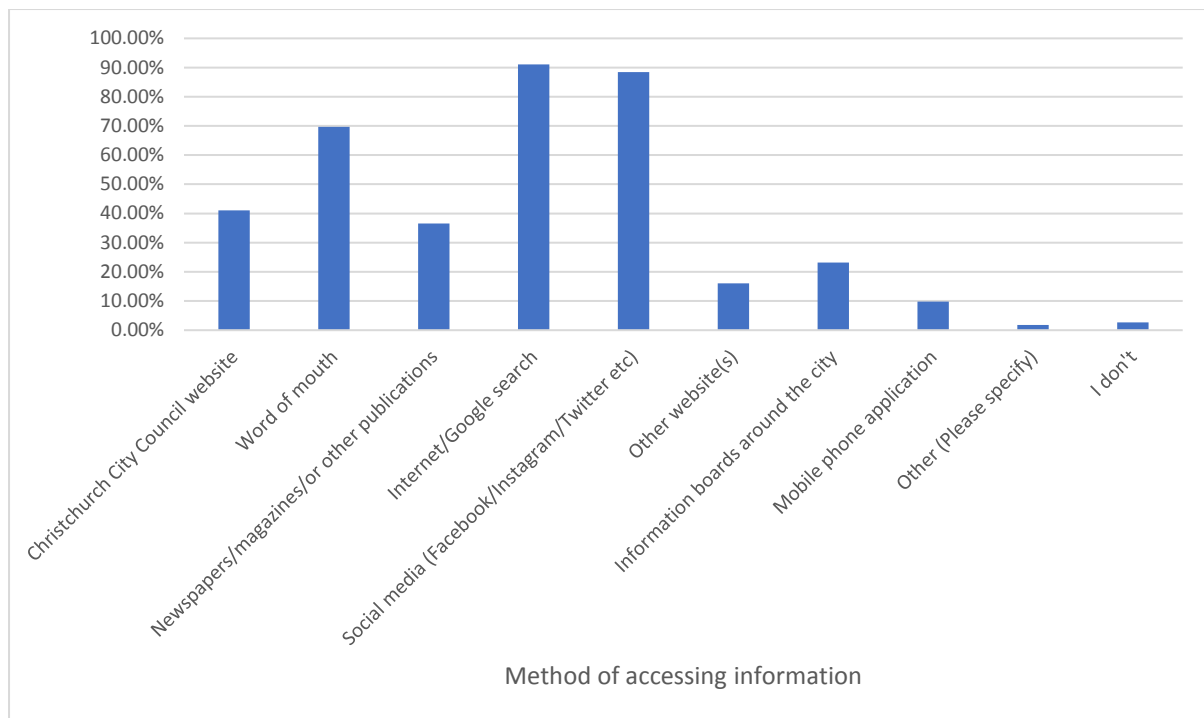


Figure 2: Respondents other methods of accessing information on Christchurch City.

34% of respondents indicated they believe the way they access information about Christchurch city could be improved, and the 66% believed it could not (Table eight). When asked how it could be improved, the most commonly mentioned theme was improving online websites and apps, followed by improving the ease of use of existing methods. Table nine shows all of the main themes mentioned by respondents considered the best ways to improve the way they access information about Christchurch City.

Table 8: Whether respondents think the way they access information about Christchurch could be improved.

Accessing information about Christchurch	Count	Percentage
Yes	38	33.9%
No	74	66.1%
Grand Total	112	100.0%

Table 9: How respondent's method of accessing information about Christchurch could be improved.

Improvements	Count
Show businesses in Christchurch on maps	2
Don't know	6
Ease of use	11
Email or cell phone updates	3
Event information in one place (online calendar)	4
Increased signs	2
Online website and apps	17
Improved social media	2

2.3 Transportation

The survey asked questions relating to respondent's transportation mode. Questions were also asked about respondent's interest in city dashboards, a programme currently in development by the Smart City Team. This was to understand more about the demographic who was involved in the survey. It also allows analysis of whether individuals who use certain transport modes would be more inclined to use any of the following smart city projects. This section will further develop on this.

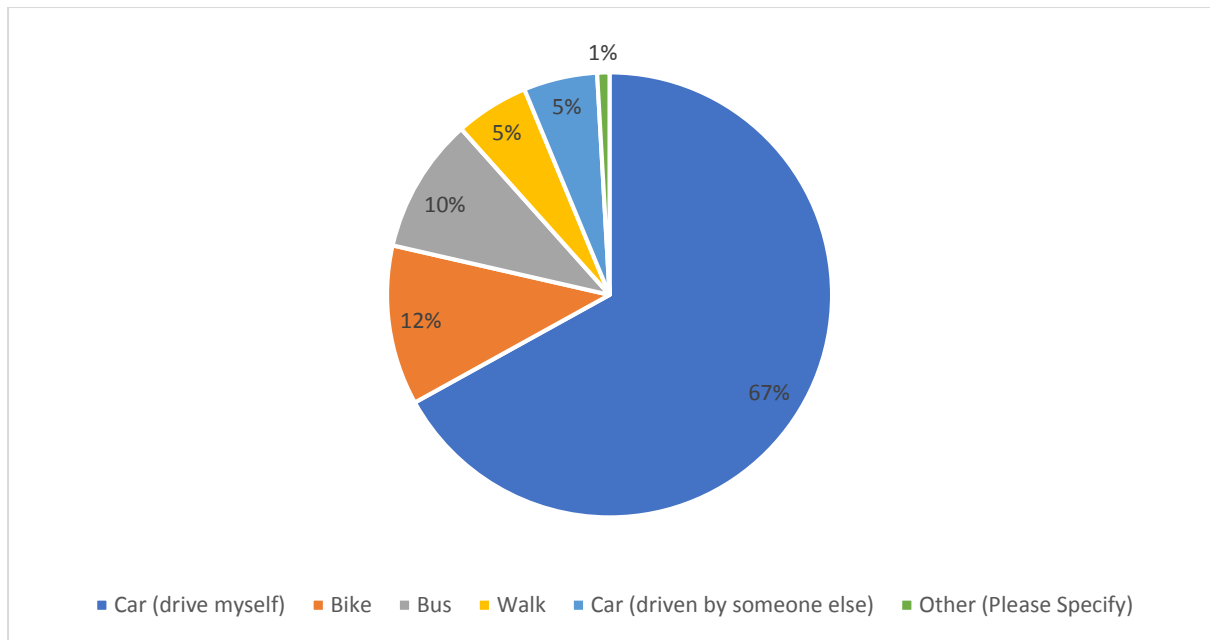


Figure 3: Main mode of transport of respondents.

Figure three shows the main mode of transport around Christchurch of survey respondents. The majority of respondents (67%) drive themselves, followed by 12% biking and 10% taking the bus. 5% of individuals walk or are driven by others, and 1% indicated they would take other modes of transport (all of these indicated they would motorbike).

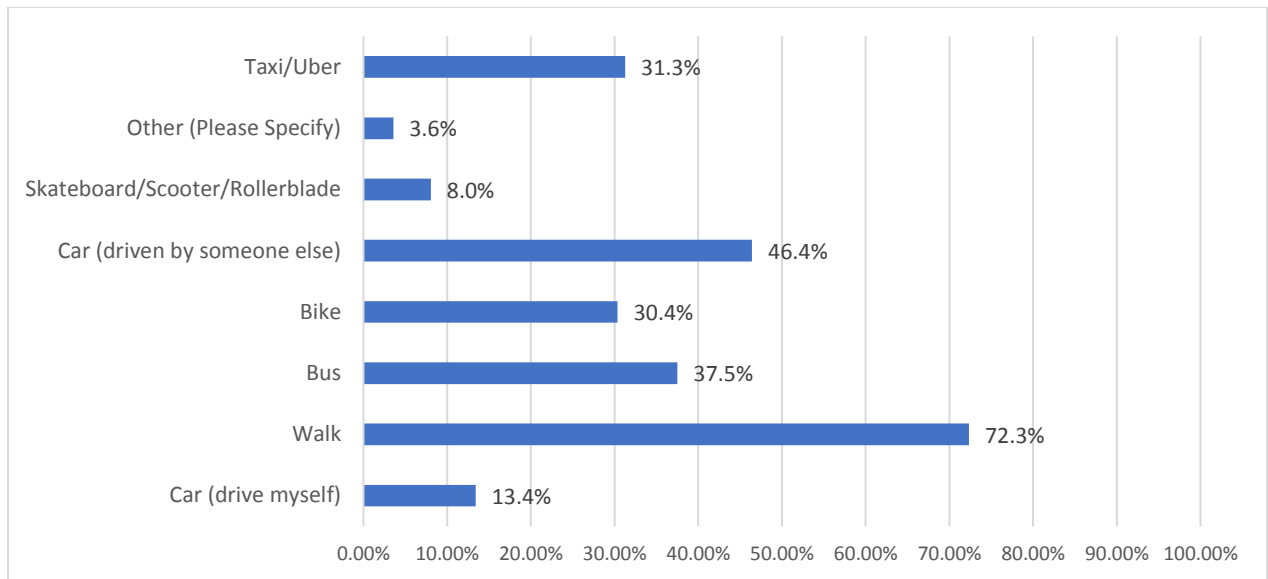


Figure 4: Other modes of transport of respondents, percentage.

Figure four shows other modes of transport employed by survey respondents. 72% of individuals indicated they would walk as an alternative, 46% that they would be driven by other, and 31% that they would take a Taxi or Uber. All of those indicating other, again said they would motorbike.

2.4 City Dashboard

The respondents were asked about the use of a city dashboard in Christchurch. They were questioned on their interest in a city dashboard in Christchurch if they would use it to access information on Christchurch city if they would add their own information to the service (open source), and what information they would like to be displayed on an application like this. The following discusses these results and looks at some demographic factors and if they influence respondent's perception of city dashboards.

Table 10: Number of respondents that would use a city dashboard application in Christchurch.

Use of a dashboard service	Count	Percentage
Yes	100	89.3%
No	5	4.5%
Don't Know	7	6.3%
Grand Total	112	100%

Table 11: Respondents who would add data if the dashboard is open sourced in Christchurch.

Add data to a dashboard	Count	Percentage
Yes	59	52.7%
No	25	22.3%
Don't Know	28	25.0%
Grand Total	112	100%

The respondents were questioned about whether they would be inclined to use this service in Christchurch, and if they would add information about it for others, as an open-sourced tool. 100 respondents (89%) indicated they would use the tool to access information about Christchurch, 5 (4.5%) said they would not and 7 (6.3%) said they did not know (Table ten). 59 people (53%) of individuals indicated they would be inclined to add information to the dashboard, 25 (22.3%) said they would not, and 28 (25%) said they did not currently know (Table eleven).

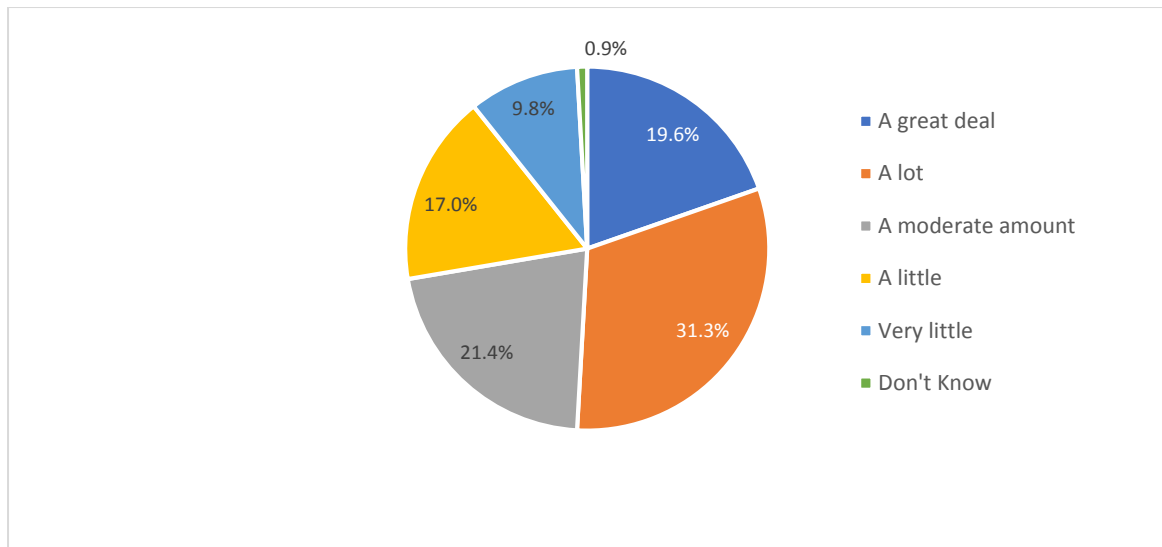


Figure 5: Respondents level of interest in a city dashboard for Christchurch City.

Respondents indicated their level of interest on a scale from zero to five, 0 being “A great deal” and five “Not at all” (Figure five). The majority of respondents (51%) indicated they would be very interested in the use of a city dashboard in Christchurch city (“A great deal” and “A lot”). 27% indicated they would use it only a very small amount, and zero respondents indicated they would not use it at all.

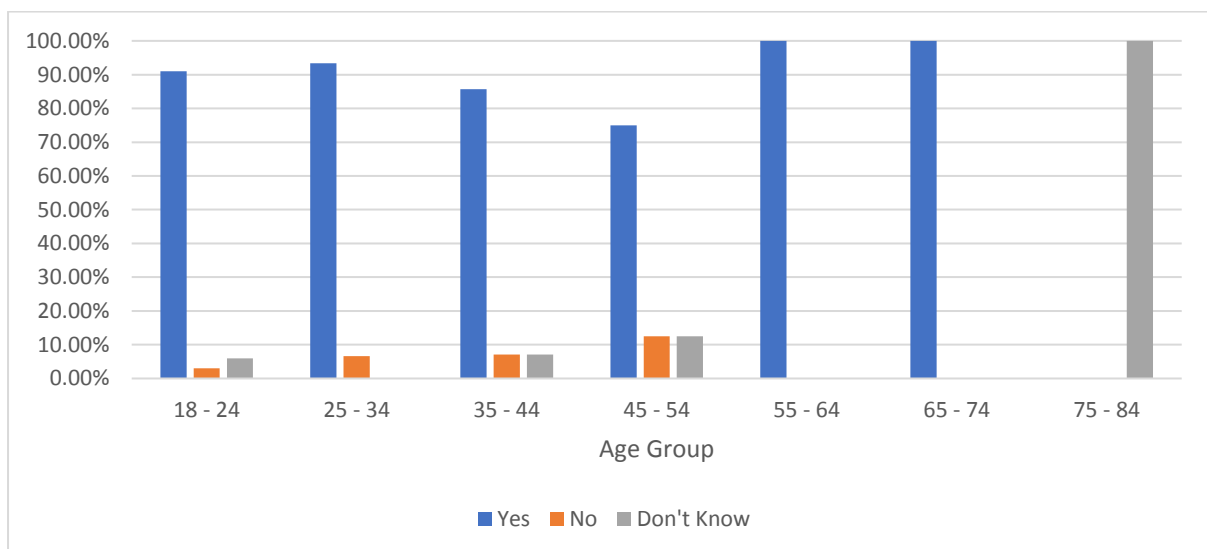


Figure 6: Percentage of respondents who would use a dashboard service based on age.

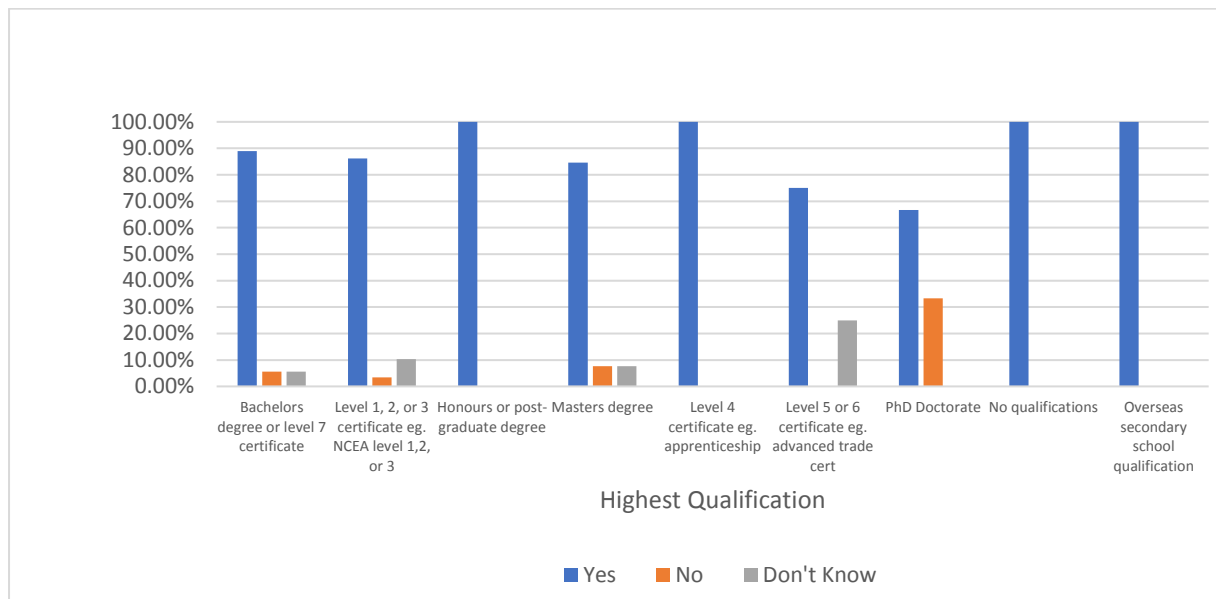


Figure 7: Percentage of respondents who would use a dashboard service based on highest qualification.

The relationship between age and engagement and respondents highest level of education and engagement with a central city dashboard have been graphed in Figure six and seven. The results here are not particularly astonishing, with all age groups and education levels indicating they would engage with this project a similar level.

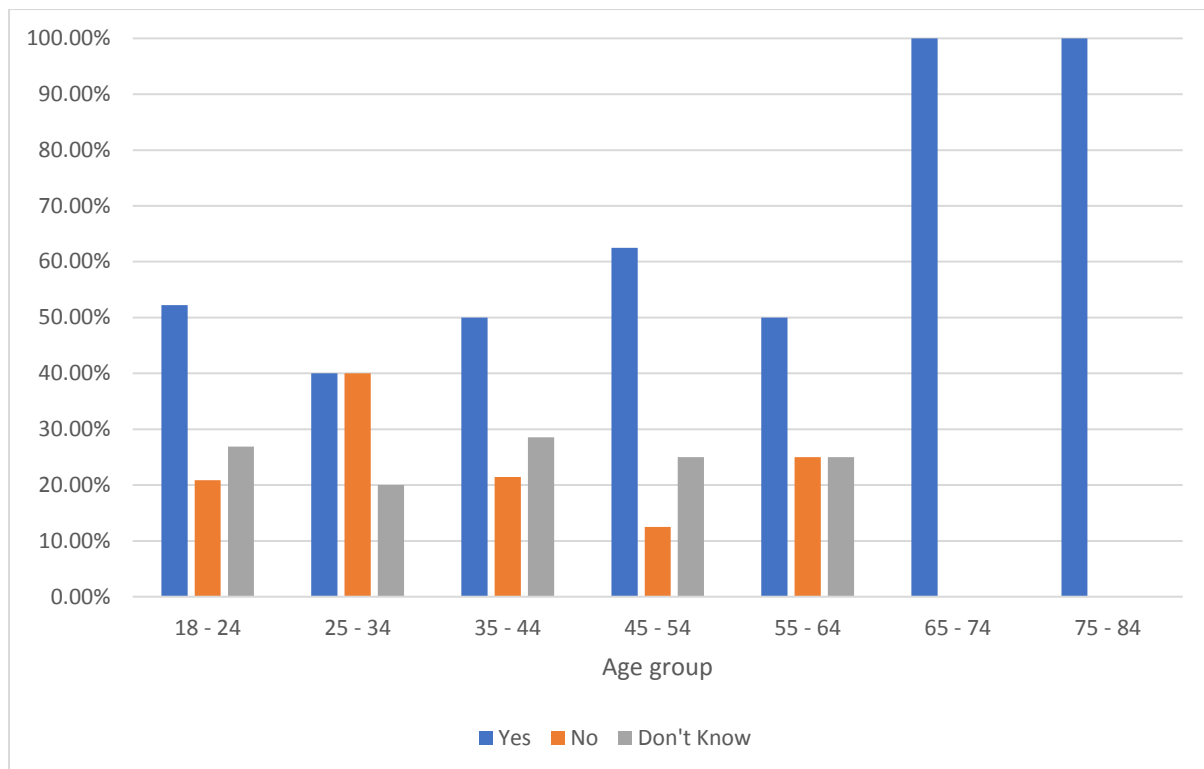


Figure 8: Percentage of respondents who would or would not add information to city dashboard in Christchurch, based on age.

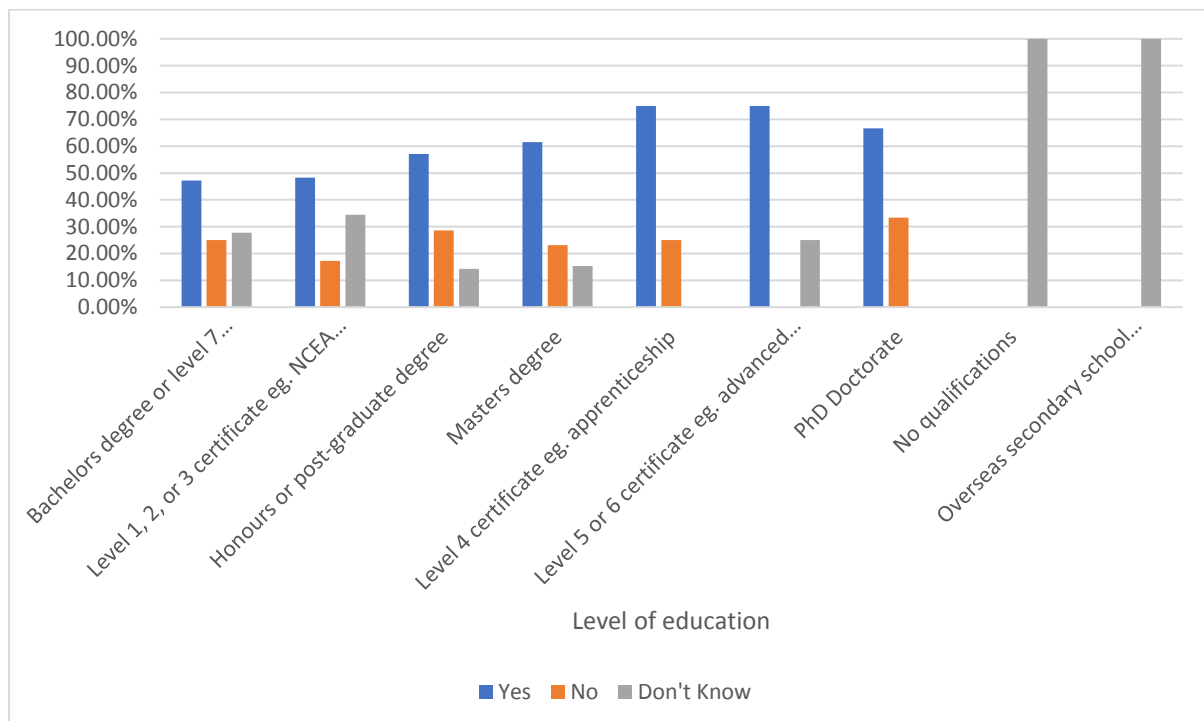


Figure 9: Percentage of respondents who would or would not add information to city dashboard in Christchurch, based on highest level of education.

Figure eight and nine show the relationship between age and highest level of education, and respondents willingness to add information to a Christchurch city dashboard. Again, this is not overly conclusive; however, in Figure eight it seems that older people are more likely to add information to a dashboard, and in Figure nine those with lower levels of education (overseas, no qualification) do not know if they would utilise that service. This is hard to say with certainty, however, as there were low numbers of participants in the survey in these categories. To confirm this, further research is required.

Table 12: Count of features respondents mentioned wanting to see on a city dashboard in Christchurch.

Features on city dashboard	Count
Activates, things to do	37
Amenities	13
Arts and culture	6
Car parking	24
Children and family	5
Construction and road closures	15
Cycling	14
Disability, age	1
Emergency situations	4
Events	34
Information and history about the city	12
Look of the application	6
New places or features	4
Open hours and busy times	7
Other	1
Parks and greenspace	10
Pedestrian	6
Public transport	13
Restaurants, cafes and bars	38
Retail	10
Reviews from the public	8
Schools	1
Sport	3
Travel details ie. Times, routes	10
Waterways	2
Weather	1

Respondents were asked what features they would like to see on a city dashboard application in Christchurch, these are all shown in Table twelve above. The most commonly mentioned theme was cafés, restaurants, and bars (mentioned 38 times), followed by activities and things

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to do in the city (mentioned 37 times) and events (mentioned 34 times). Also mentioned a number of times were ideas to do with the layout of road systems, like the location of car parks (mentioned 24 times), areas of construction and road closures (mentions 15 times) and information about cycling including the location of cycle parks and cycle lanes (mentioned 14 times). This information will be discussed further in the recommendations section of this report.

2.5 City Wifi

One specific project with direct influence on users of Christchurch City is the central city free Wifi project. Respondents were asked to what extent free central city Wifi in Christchurch would be of benefit to them. The following section shows these results.

Table 13: Count of respondent's use of a free Wifi service in Christchurch central city.

Free Wifi service in Christchurch	Count	Percentage
Yes	104	92.9%
No	8	7.1%
Grand Total	112	100%

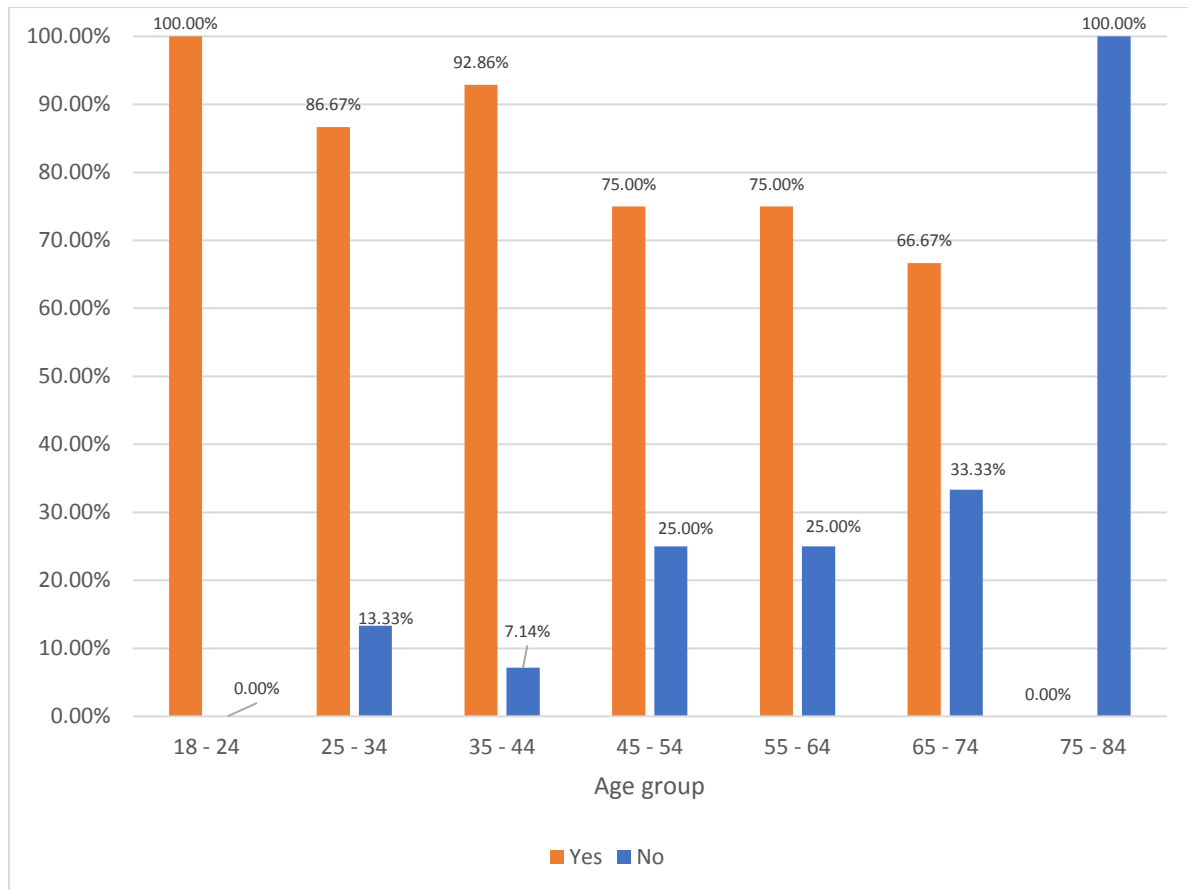


Figure 10: Percentage of respondents indicating they would use central city free Wifi by age.

Table 14: Extent respondents would use a free Wifi service in Christchurch central city.

The extent of use of free Wifi service	Count	Percentage
A great deal	40	35.7%
A lot	25	22.3%
A moderate amount	21	18.8%
A little	21	18.8%
None at all	5	4.5%
Grand Total	112	100.0%

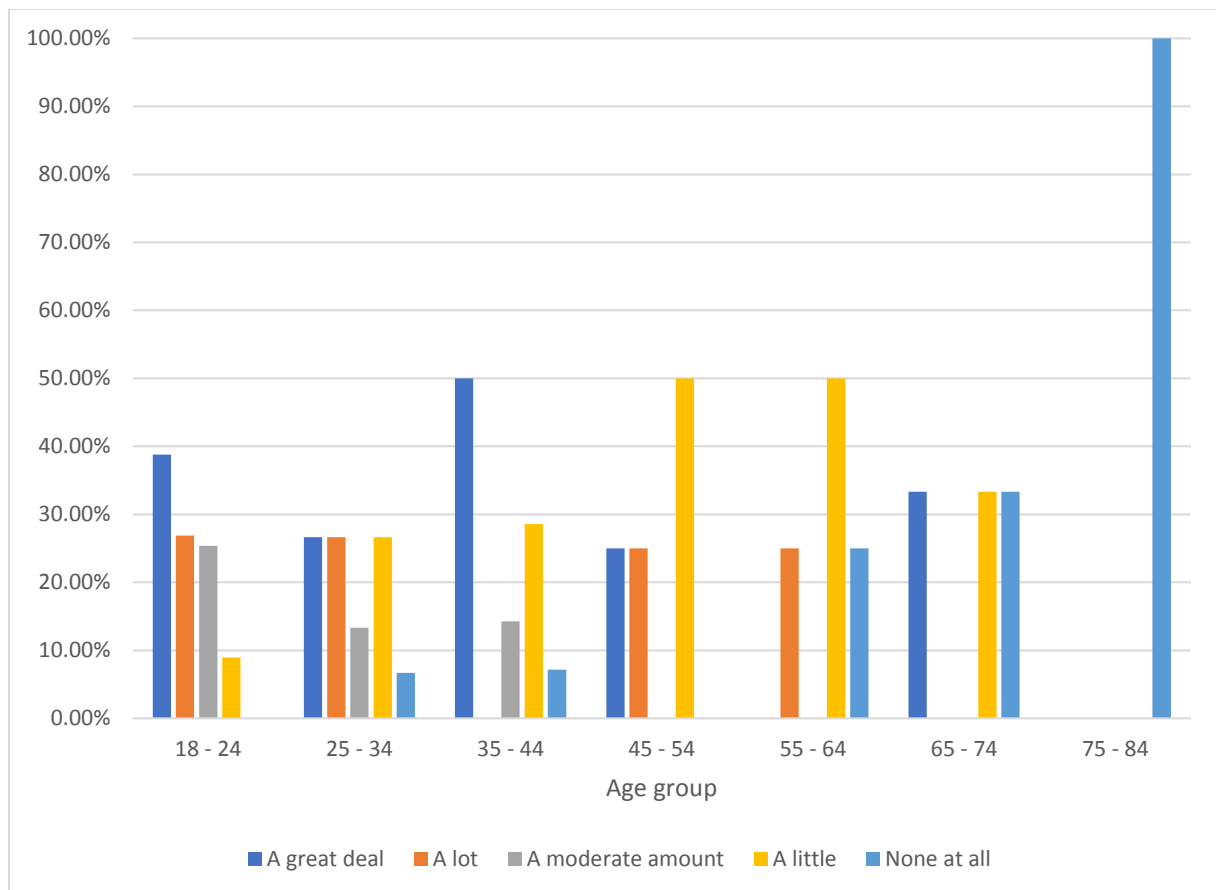


Figure 11: Percentage of the extent to which respondents would use a free Wifi service in Christchurch central city in relation to their age.

Table 15: Count of respondents and whether free central city Wifi in Christchurch would be an incentive to come into the city more often.

Free Wifi an incentive to come into the city	Count	Percentage
Yes	61	54.5%
No	34	30.4%
Don't Know	17	15.2%
Grand Total	112	100.0%

Table thirteen shows that the vast majority of individuals indicated they would use free central city Wifi (93%) with only 7% of people indicating they would not. When compared to age in Figure nine, the majority of those within the 18 – 44 age brackets indicated they would use the Wifi services, and high proportions in the 45 – 84 brackets indicated they would not use the service.

Similarly, the largest number of people (36%) indicated that they would use free Wifi a great deal, and 22% said they would use it a lot. 19% indicated they would only use it a little, and 4.5% that they would not use it at all. This is shown in Table fourteen. Also, Figure ten shows a similar trend to that discussed above, that older age brackets would use this service less often, although this is not as clear.

Finally, 55% of individuals (61) said that free Wifi in Christchurch central city would be an incentive to come into the city more often. 30% indicated that it would not, and 15% were unsure (Table fifteen).

2.6 Mobility Parking

Respondents who personally use/have used mobility parking spaces in Christchurch or know of someone how does where asked a variety of questions relating to these in Christchurch. These included how often they use them, how satisfied they are with them, what they would change and if they would use a mobile application to help find and track mobility parking in Christchurch, and why or why not. Table sixteen shows the number of respondents that have used, know of someone that has, or does not use mobility parking in Christchurch.

Table 16: Respondents use of mobility parking in Christchurch City.

Use of mobility parking	Count	Percentage
Yes, I have personally	6	5.4%
Yes, someone I know closely has	20	17.9%
No, or I am unsure	86	76.8%
Grand Total	112	100.0%

Table 17: Respondents frequency of use of mobility parking in Christchurch.

The frequency of use of mobility parking	Count	Percentage
4-6 times a week	3	11.5%
2-3 times a week	4	15.4%
Once a week	8	30.8%
Once a month	4	15.4%
Only a couple of times in total	5	19.2%
I don't know	2	7.7%
Grand Total	26	100.0%

In Table seventeen, of those that indicated they do or know of someone that uses mobility parking, 12% use them 4-6 times a week, 15% 2-3 times, the highest percentage 31% use them weekly, 15% once a month and 19% only a couple of times total. Also, 7.7% indicated they don't know.

Table 18: If respondents agree or disagree that mobility parking in Christchurch is adequate for their, or an individual they know, needs.

Mobility parking is adequate	Count	Percentage
Agree	3	11.5%
Somewhat agree	3	11.5%
Neither agree nor disagree	2	7.7%
Somewhat disagree	6	23.1%
Disagree	5	19.2%
Strongly disagree	3	11.5%
Don't know	4	15.4%
Grand Total	26	100.0%

In relation to if respondents agree or disagree that mobility parking is adequate for their needs, no one indicated they strongly agree, 12% indicated they agree and the same amount that they somewhat agree. 7.7% answered they neither agree nor disagree, 23% somewhat disagree, 19% disagree, and 11% strongly disagree. The majority here answered within the disagree category (54%) and 15% indicated that they don't know (Table eighteen).

Table 19: How respondents would improve mobility parking in Christchurch.

Improvements to mobility parking	Count
Price	1
Don't know	3
Information accessibility	5
Location and access to other areas	5
Other	2
Park availability and frequency	12
Park design ie. Ramps, curbs	4
Park size	1
Penalties for misuse	4
Reviews and ratings of parks	1
Wouldn't improve	1

Respondents were asked what would improve mobility parking in Christchurch, most commonly respondents indicated increasing or improving the availability and frequency of parks in the city, to save walking long distances, and find parks easier. Second most common is information accessibility and location in relation to other areas. This is shown in Table nineteen.

Table 20: Why respondents would use an application displaying information of mobility parking in Christchurch.

Reason for use of the application	Count
Accessibility	2
Don't know	2
Ease and time	3
Knowledge of parks	4
Location	2
Other	5
Poor design	1

Table 21: Why respondents would not use an application displaying information of mobility parking in Christchurch.

Reason for not using application	Count
Lack of technological skills or don't own a smartphone	5
Not applicable	6

Respondents were asked if they would use an application to access information about mobility parking in Christchurch and why. Table twenty and twenty-one show reasons why respondents indicated yes or no. Most common for those that indicated yes, said it would be helpful to increase their knowledge of existing parks, like how they would suit a backward or sideways opening vehicle, and how far it would be to walk or travel to their destination. Also mentioned was ease of use, and the time it would take to get to.

Those who indicated no did so for two reasons, one, because they do not have access or the skills to use a smartphone, and two, it was not applicable (as they were answering on behalf of others).

2.7 New Projects

Respondents were asked for their perspective on new smart city projects in Christchurch City. They were first asked to rank the City Council's Smart City Strategic Goals from least to most important, the types of new projects they would like to see in Christchurch, how they understand the term "smart city", and what issues or barriers they perceive with the smart city project in Christchurch.

Table 22: Count of ranked Smart City Strategic Goals from 1 (most important) to 6 (least important).

	Enabling active citizenship and connected communities	Maximising opportunities to develop a vibrant, prosperous and sustainable 21 st -century city	Climate change leadership	Informed and proactive approaches to natural hazard risks	Increasing active, public and shared transport opportunities and use	Safe and sustainable water supply and improved waterways
1 (Most Important)	21	38	20	5	17	23
2	20	20	23	8	24	20
3	14	21	17	11	32	16
4	14	13	14	21	26	21
5	17	10	20	31	6	20
6 (Least Important)	25	9	17	35	6	11
Average	3.54954955	2.675675676	3.378378378	4.531531532	2.981981982	3.252252252

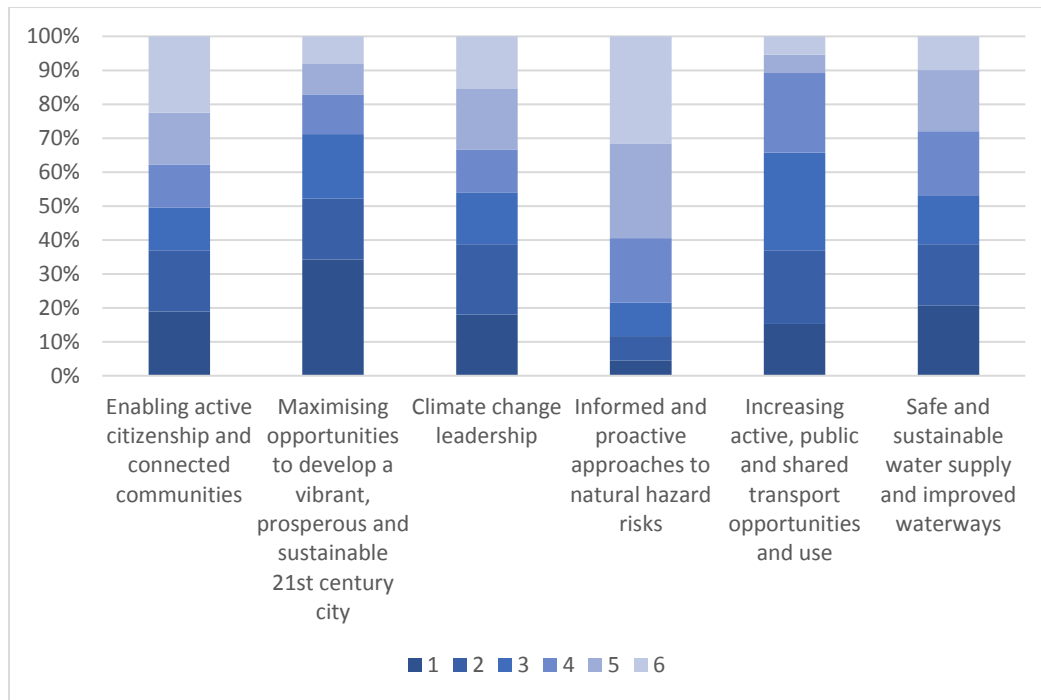


Figure 12: Strategic goals of the Smart City Project - Ranked from 1 to 6, 1 (most important) and 6 (least important).

Respondents were asked to rank the CCC’s Smart City Strategic Goals from one to six (1 being most, and 6 being least). Table twenty-two shows the highest number of respondents indicate that “Maximising opportunities to develop a vibrant, prosperous and sustainable 21st-century city” was the most important and the least, with the highest number of respondents responding with a six, being “Informed and proactive approaches to natural hazard risks”. By looking at both Table twenty two and Figure eleven it is evident that “Maximising opportunities to develop a vibrant, prosperous and sustainable 21st century city” and “Increasing active, public and shared transport opportunities and use” were the highest rated overall goals (shown by average in Table twenty two and the amount of dark blue in Figure eleven). On average, “Informed and proactive approaches to natural hazard risks” is the least important goal for respondents.

Table 23: Count of new projects ideas for Christchurch discussed by respondents.

New project ideas	Count
Amenities (number, type, access)	3
Art and culture initiatives	6
Cycling initiatives	9
Energy use	3
Events (new, improvements, access, free)	5
Green space initiatives	1
Historical initiatives	1
Information access	4
None	12
Other	5
Parking initiatives	15
Phone and app-based technology	8
Public transport initiatives	10
Road use (pedestrian streets, shared streets, slow streets)	3
Safety initiatives	5
Shared spaces	1
Traffic predictions and transport	8
Waste	2
Wifi (Buses, city etc)	5

Table 24: Respondents count of ideas of a smart Christchurch.

Smart Christchurch concepts	Count
Affordable	1
Biophilic	5
Car dependency	4
Connected	2
Cycling and pedestrian-focused	5
Density	1
Don't know	4
Economically sound	2
Environmental sustainability and energy use	14
Inclusive and accessible	6
Informative	10
Innovative	5
Integrated urban design	3
Other	2
People focused	17
Public transport focused	7
Road system and safety	2
Personal safety focused	1
Smart parking initiatives	7
Technological	22
Transport solutions	5
Unique and vibrant	7

Table 25: Count of respondent's issues and barriers to the Smart City project in Christchurch.

Issues and barriers	Count
Car dependency	1
Cost	5
Education	3
Lack of consultation	3
Less interaction with the city	6
No issues	36
Non-inclusiveness	5
Other	2
Overseas examples	1
Perceptions of smart cities and new technology	5
Safety and privacy	8
Some projects are not necessary	1
Smart city project takes away from other council responsibilities	1
Time	1
Wifi	7

Respondents then indicated new projects ideas they would like to see implemented in the city. This is shown in Table twenty-three. The most common ideas mentioned were to do with increasing car parking or finding new solutions to parking in the central city. The second was improving the public transport system in the city. Mentioned 12 times was also that individuals wanted no more smart city projects.

Table twenty-four shows common answers from respondents on what a smart city is. The most common responses focused on the city being technological, followed by people focussed, and being environmentally sustainable and having environmental energy consumption techniques. Finally, Table twenty-five shows respondents perceived issues and barriers to smart city technology in Christchurch. The most common responses were to do with safety and privacy, and issues with the free Wifi network. 36 individuals said they had no issues.

2.8 Location information

Participants residing in Christchurch were asked in which suburb they reside, this information was gathered for the majority of respondents. This was in an effort to understand if respondents location in Christchurch would have an effect on individual's understanding of smart cities, the type of smart projects they would be most likely to engage with. However, upon analysis, this did not reveal any significant information. Reasons for this will be discussed further in the limitations section of this report, however, future research should consider how residential location could affect individuals use and understanding of smart city technology.

2.9 Key findings from the survey

Each section highlights a number of key points that are used in the next chapter to understand smart cities and residents perspectives of these in Christchurch. First, some basic information and demographic data were asked. Section 2.1 shows demographic information about participants, a larger proportion of respondents in this survey were females, the majority are in younger age brackets, there is a low proportion of races other than European, and there were more respondents with higher levels of education. The implication of this will be discussed in the discussion chapter of this thesis report. In section 2.2, respondents indicated that they usually gather information about Christchurch through online sources including social media and the internet, and in section 2.3, results specified that two-thirds of respondents main mode of transport were by car.

Second, the perspective of respondents on the three smart projects being assessed in this thesis was questioned, being SmartView or a Christchurch City dashboard, smart mobility parking, and CBD free Wifi. Interest in a city dashboard, shown in section 2.5, is high, and more than half of respondents indicated they would be interested in adding information, through open sourcing, to the project. There seems to be less interest in this project from older generations, however, due to the small number of older respondents this may not be conclusive, this will be discussed further in the discussion chapter. Similarly, interest in the CBD Wifi was high, and a large proportion of individuals indicated that this would be an incentive to come into the city. Again, older respondents indicated they would engage less, and the implications this will be discussed in the next chapter. Around 60% of respondents indicated that current mobility parking is not adequate for their needs. Questions about smart mobility parking in Christchurch, shown in section 2.6, suggested that the main issue with parking currently is its availability and frequency, and an app to show information about mobility parking and other information could help to mitigate this and other issues. However, respondents expressed worry that mobile applications would not be of use to many elderly, without the use of cellular devices or the internet.

Finally, when questioned about the CCC Smart City Project's strategic goals in section 2.7, respondents indicated that "maximising opportunities to develop a vibrant, prosperous and sustainable 21st century city" and "increasing active, public and shared transport opportunities and use" were the highest rated overall goals, and "informed and proactive approaches to natural hazard risks" were the least. Parking initiatives, public transport and cycling based smart projects were the most commonly acknowledged new projects that respondents wanted to see in the city, and when defining the smart city, the most commonly mentioned themes were technology focused, built for people, and focused on the environment and sustainability.

There were few major issues from respondents, most common being security and safety risks caused by smart technology were discussed by respondents.

These points will be discussed further and compared to results from the literature, and the other research in this thesis.

3 Focus Groups

From the two focus groups conducted, a number of observations were made. This section will outline these, to be discussed in relation to each other method of research in the next section. Each focus group had six participants, who will be identified in this research through numbering system to maintain confidentiality. For instance, participant number three from focus group two will be identified as F23, “F” indicating focus group, the two representing the second focus group, and the three indicating they are the third identified participant of the focus group. The discussion from these focus groups was broken into a number of key points, these being; 1) generic smart city questions, including what a smart Christchurch would look like to the participants, and how they gather information about the city and how this could be improved; 2) current smart city technology in the CCC’s Smart City Project, including SmartView, CBD free Wifi, and smart mobility parking; 3) and, new smart projects that the participants would like to see, which groups should be targeted, how they would like to access information about smart projects in the city, and the best form of consultation for future projects. The results from these focus groups will be discussed in relation to these three sections, followed by a number of key insights gained from this research being highlighted, to be deliberated further in the discussion chapter of this thesis project.

3.1 Generic smart city questions

Participants were asked how they would define ‘smart Christchurch’, and what technology they envisioned in the city in the future. A number of themes were discussed, the first focus group predominantly concentrated on parking, the use of roading infrastructure and transport. Smart Christchurch was described a city that is safe, clean, easier to access, less cluttered, brighter in design, smooth flowing, and an easy place to access information without having use devices like phones. Again, transport was the main focus of the discussion, participants wishing to see; new initiatives for smarter cars, like autonomous vehicles and those with built-in map and direction systems; improvements to public transports, like smaller busses and taxi or Uber shuttle bus services; and, improvements to parking infrastructure and systems, for instance applications to indicate available or free car parks, parking hubs with pick-up and drop-off services, and more electric car charging locations. Participant F13 expressed they believe improving car access and parking in central Christchurch would aid in “bringing life” to the city, as it were pre-earthquake. This individual and others mentioned access to the CBD at current is inadequate, referring predominantly to vehicle access. Improvements to current parking facilities could be achieved through smarter parking solution, like those mentioned above.

Focus group two described “smart Christchurch” as autonomous, intelligent, environmental, and accessible physically and in terms of information, with better traffic flow, and is both safe and clean. They focused far less on parking as in focus group one, rather concentrating on the efficiency of the city as a whole and for its people. They discussed smart Christchurch as having well-managed waste and rubbish, no graffiti, vast greenspace, and a focus on people using the

CBD rather than periphery suburbs shopping centres and hubs. Simply, smart Christchurch will focus on improving the function of the central city for the people of the whole city. Participant F21 mentioned Wellington City as an example of a city which is alive, “you want a living city centre” F24 offered, referring to the fact that well-functioning cities are alive, with people, events and things to do generally. The participants agreed this was key to a smart Christchurch and new technology is required to support this.

Participants were then asked how they access information about Christchurch and the city, and how they would like to in the context of a smart Christchurch City. Most participants in focus group one agreed that too much time is spent looking at phones when using the city, as this is their main form of accessing information at current, and more focus needs to influence individuals to see the city itself. They agreed that phones are important in accessing information, however, more focus needs to be put on offering information about the city through physical displays within the urban environment of the CBD. Information boards, small billboards, and interactive displays were discussed, and again referring to parking, the group agreed more signs like those displaying information about available parking on main roads into the city would be beneficial.

Focus group two held similar opinions to these, discussing physical and interactive displays of information in the city being integral, but also saw value in improving mobile applications with information through allowing open sourcing and real-time data to be displayed. “There are already social emails and communications, like Awesome Christchurch” F23, acknowledged when discussing email networks for circulating information. The participants agreed that streamlining these email lists and applications, and creating one main application to portray all information would be beneficial to improving their access to information about the city.

3.2 Smart projects in Christchurch

Secondly, participants were questioned on their opinion of the three smart projects in the CCC's Smart City Projects that have been discussed in this report, SmartView, CBD free Wifi and smart mobility parking solutions. They were given a description of each project, and shown the Beta of SmartView on the internet, and asked if they would use it or they could understand its use for other, who the project should target, how and why they would use it or not, concerns with the specific project, and how it could be best used in Christchurch.

3.2.1 SmartView

Focus group one acknowledged SmartView as a good step forward in attempting to streamline access to information about Christchurch city. F11 mentioned the value it would be to visitors to the city, as it offers a large amount of information relevant to those unfamiliar with the city, like the location of public toilets, drinking fountains and car and bike parking facilities. The consensus of the group was in favour of the SmartView application, and the majority of the current information available on the application. They indicated they would like to be able to use the app, and specifically the map location feature, to find nearest car parks, restaurant and bars including their location, ratings, menus and opening hours, services like supermarkets, petrol stations, mechanics, and medical centres, and locations of dangers like fires, roadworks, details of earthquakes, and other safety information in real time. F16 acknowledged the value of making the application open sourced to allow comments about facilities and issues to be reported directly to the CCC, similar to the CCC's Snap-Send-Solve application, which allows the community to report issues like potholes, missing street signs and other similar information directly to the CCC. The group expressed concern with the use of the application for some

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groups including the elderly, who do not have access or the knowledge to use technology like this application. They were also wary of the application becoming commercial, with organisations paying for the rights to include information about their own business over others, and the group expressed that the application must remain free from advertising and commercialism.

Focus group two shared some similarities with the viewpoints of focus group one, wishing SmartView to display information about parking space location and availability, restaurant and bar locations and information, although again expressed worry that the application could become too commercial if the CCC is not careful, the need for the app to be open sourced, and issues with accessibility of the app for the elderly and groups typically less technologically intelligent. The expressed the apps need to be easy to use on mobile devices and the fear that if too much information became available on the application it would become unusable to perform simple tasks like finding public toilet locations. The group discussed how the application could to support other smart projects that could be introduced by the CCC Smart City Project, including displaying electric vehicle charging stations, and the location and means to access new technology-focused alternative transport modes, for instance, cycle sharing projects, and shared taxi or Uber services.

3.2.2 CBD free Wifi

The Christchurch City CBD free Wifi project met more distrust from participants in both focus groups. Participant F12 was quick to acknowledge the cost of the project, indicating they would not be willing to pay any more rates for this service. The first focus group acknowledged that free Wifi should be a part of all future cities, but agreed that they would not be willing to pay

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for it. The group expressed an issue with individuals like homeless and travellers in the city having access to the service and agreed that it would have to have a small per day limit otherwise some individuals would take advantage of the service, downloading movies or music and again risking raising taxes to pay for these individuals use. Again, they acknowledged that this project will unevenly effect some groups in Christchurch, especially elderly who have no use for or are not willing to use the Wifi service.

Focus group two were generally more optimistic about the free Wifi project. F21 mentioned they believe that this type of service is becoming more affordable, and will be integral to all large cities in the future, some of the group agreed, but a number again expressed worry that this will increase rates for themselves. The group agreed data use should be capped, and eventually came to the conclusions to "...just do it." – F24, the free Wifi project overall will benefit the city, especially those who typically don't have access to these services, like travellers and homeless, in contrast, to focus group one who considered this a negative. The free Wifi project would influence more people to travel into the city and help everyone to find new and interesting parts of the city typically forgotten or unknown. Both focus groups overall agreed that the project would be an important step forward in Christchurch's goal to become a smart city, but the cost and rules will need to be discussed and made known to residents in Christchurch.

3.2.3 Smart mobility parking

Finally, the participants were offered information about potential smart, technology-focused solutions to improve mobility parking in Christchurch, specifically in the CBD. Some participants had experience, or knew of others with experience, using current mobility parking

in Christchurch, but all participants offered insight from their own knowledge about how they would improve mobility parking through smart city technologies. Focus group one discussed some basic adjustments to the parks themselves, including making them longer and wider, and easier to access. F11 indicated that the SmartView application could aid in improving access to these parks, including showing their locations, availability through a similar system to the new CBD parking buildings with a sensor under each park, and the distance from these parks to other services in town. The group discussed how smart technology could be used to stop individuals without permits using these parks. They discussed ideas like numberplate readers, sensors that automatically recognise the car, card scanners, and alerts that go directly to the CCC when individuals without permission park in these parks. Other suggestions included adding electric vehicle charging stations to all parks, increasing their number across the city, and signs around town indicating the location of these parks. The group acknowledged the predominant group using these parking spaces is elderly, so smart solutions to improve mobility parking must be simple to use, and available to all, especially those who do not use mobile devices.

The second group also acknowledged the technology issues that elderly could experience if solutions are mobile application based. Again, they discussed how SmartView could be used to mitigate many issues, especially availability, but stressed the importance of making this accessible to all groups in society. They suggested audio stations located at each park, with information on how they work, if they require swipe card access, and how to use mobile applications if this is applicable. F23 suggested as well as feedback being given through the mobile application, there be physical feedback services available at each park, so individuals can provide information on how the parks could be improved for them. Again, this group suggested sensors, number plate readers, and feedback services to dis-incentivise individuals

without permits from using the mobility parking spaces. The group finished by expressing there needs to be further consultation with affected groups, predominantly the elderly and individuals with varying disabilities, to understand how these parking facilities could be improved for the diverse types of groups that will be using the services.

3.2.4 New projects and consultation

Finally, participants were asked to discuss, based on the projects previously discussed, what new smart technology they would like to see in the city, how it would affect them or others, and what issues they perceive with the project overall. As mentioned, focus group one concentrated on transport and parking, mentioning wanting to see new and better system in place to pay for parking in the city, through the SmartView app potentially, and options to pay for those without access to mobile devices, through scannable cards or similar physical items. They also discussed increasing security in and around the city as of key importance, especially at night times. They acknowledged three main issues with the current design of the CBD in Christchurch, security as discussed, poor cycle lanes, and inaccessibility for those with disabilities, families with prams and children and the elderly. They concluded that these should be the focus of new smart projects in Christchurch. Focus group two also discussed safety, saying better and more environmental lighting solutions should be implemented around the city. They discussed how Christchurch needs to start to invest in solar power for these new projects, and this could aid these new lighting solutions. They also acknowledged the city needs to be better designed for everyone, and consultation is key to ensuring this.

3.3 Key insights from focus groups

The key insights gained from the focus group process are;

1. According to these two groups, Christchurch as a smart city should be safe, clean, bright, smooth flowing, autonomous, intelligent, environmental, green, and focus on improved traffic flow, public transport improvements, smart and electric cars, efficient design, and designing a city that is alive with people and events.
2. Information should be accessible to all, it should be available through mobile applications and the web, but also interactive information boards in the city, and other physical infrastructure for those without the access to, or knowledge of, technological information sources.
3. SmartView will be an important device for Christchurch if done properly. It must be open-sourced, acknowledge diverse groups like elderly in Christchurch, and be built on consultation.
4. CBD free Wifi is important for Christchurch to become a future city, but it also must be built on consultation, and not come as an extra cost to residents of Christchurch, especially considering it will affect groups unevenly, especially elderly.
5. Smart mobility parking also must take into account the number of different groups and individuals that will be using the service, and how it can best suit their needs. Accessing information about these must be simple for those without pre-existing knowledge of technology like mobile applications. There needs to be consideration of how to streamline the parking system and dis-incentivise individuals without permits from using these parks.

6. Safety and lighting, transport and parking, the uneven effect some projects will have on some individuals, accessibility and consultation are key issues that should be considered with the development of new smart projects in Christchurch.

Chapter 5: Discussion

1 Introduction

This chapter will discuss trends from the data gathered in this thesis project in relation to examples of smart cities in literature and internationally. It will discuss the literature gaps initially mentioned, and offer solutions to a number of these, including the value of engagement in smart city projects, and how to increase this level of engagement through said projects. A number of key insights gained through the research process will be discussed, and this will be broken into three sections, relating to points that have emerged through the research process, and that relates back to the review of the literature in chapter two.

1) Redefining the smart city in Christchurch. This section will discuss the definition of smart cities, it's ambiguity in research and in practice, and the definitions discussed by respondents to interviews, survey and focus groups. It will suggest how to define the smart city concept in relation to the context of Christchurch city itself and offer a new definition of smart cities, created through the process of consultation, and taking into account the goals of the CCC and definitions through literature and internationally.

2) Community perceptions of the smart city, and their effect on behaviour change. This will address the second and third research objectives;

(2) To understand ways to communicate these smart cities technologies to effect behaviour change, including how to consult communities in the city about smart city technologies, how to circulate information relating to these projects, and what sort of projects will be most meaningful to the users, residents and visitors, of the city.

- (3) To understand community perceptions of the Smart City Project in Christchurch, what they wish to gain from current Smart Cities projects like SmartView, and what new projects they would like to see in the city.

Post-disaster Christchurch has had influence on urban and community development and has been driven by community resilience. How community resilience has affected the city has been discussed in the literature review section, but how it will impact and could be used to support The CCC Smart City Project will be discussed. This will question whether the Christchurch earthquake sequence has had an effect on the smart projects and their development, or if this context has not had an effect overall on the Smart City Project. A discussion will be had about how participation in smart city planning can affect behaviour change in the users of a city, and how this can occur in Christchurch and internationally. Finally, the definition of meaningful data understood through this thesis project will be highlighted, and a discussion of how smart projects can create this type of data and issues with this including safety concerns that have been prevalent throughout this research project will be considered.

3) Suggestions for the Christchurch City Council's Smart City Project, and smart city projects internationally. This final section will offer suggestions for the CCC Smart City Project and other national and international smart projects, based on information gathered through literature, international examples, and the research conducted in this thesis report. It will look at the current Smart City Strategic Goals for the CCC's project, analyse if these are relevant to the individuals consulted in this project, and suggest edits to these. It will suggest appropriate ways to consult individuals on smart technology and new projects in Christchurch and internationally, will discuss issues that need to be addressed by the project, and use The CCC

Smart City Project and the results gathered through this research project as an example for new or existing national or international smart city projects.

The final part of the discussion chapter will highlight the limitations of this research project in relation to the methodology and insights gained after the completion of the research, and how these could be mitigated. It will acknowledge limitations of the research, with respect to the demographics of participants, and overall level of engagement, and again pose suggestions for further research in this area. It will finally reaffirm how this research can be used as a start point for participation based research to support new smart city technology to improve smart city projects, like in Christchurch City, into the future.

2 Redefining the smart city in Christchurch

This section aims to offer a definition of the smart city in Christchurch, with reference to community perceptions, definitions in literature, international examples of smart cities, and the overall context of the city. This will fill a gap in current research, at least in regard to Christchurch, where no one definition of a smart city is applicable to the city. Reasons to re-define the smart city will be discussed in more detail, then a new definition will be offered.

2.1 Reasons to redefine in the context of Christchurch

The term smart city is ambiguous and widely debated. Academics, organisations and governments still have varying understandings of the term (Caragliu, Del Bo, & Nijkamp, 2011; Glasmeier & Christopherson, 2015; Kitchin, 2015; Marek, Campbell, & Bui, 2017).

International smart cities define the concept of smart cities without reference to the context of the city itself, for instance Amsterdam Smart City is defined as a platform for innovation, challenging companies, citizens, and institutions to apply technology-focused innovation in an attempt to address urban challenges and future sustainability (Amsterdam Smart City, n.d). Key to this definition are themes discussed as goals of the city's smart project in the literature review section of this report, to reiterate these are Infrastructure and Technology; Energy, Water and Waste; Mobility; Circular City; Governance and Education; Citizens and Living; and the Smart City Academy (Amsterdam Smart City, n.d). Although this definition indicates the specific focus of this smart city project through these seven points, it lacks consideration of the context of the city, for instance, it does not make reference to the city's population surge occur currently, an issue that smart urbanism and technology could help to solve (Future Cities, 2017). However, Wellington City Councils smart city project is defined by acknowledging the city's citizens as highly skilled and integral to the process of becoming a smart city, and a set of values that reflect the city's culture and character that already exist (Wellington City Council, 2011). These two points set the objective for Wellington's smart project, aiming to use the existing context of the city as a driver for smart projects. As previously discussed, Barcelona, Amsterdam, Singapore and Wellington are recurring examples of smart cities internationally, and although Amsterdam doesn't specifically mention it when defining their smart city, the process in which they operate considers the context of the city, which can be seen through their website and projects (Buntz, 2016) (Frearson, 2017).

Christchurch needs to consider these international definitions when planning its smart city project, and therefore in its definition of the smart city. But, the CCC must compare their Smart City Project to the context of the city, especially the perceptions of the users of the city themselves. Respondents to this research were asked to define how they perceive a smart

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Christchurch looking, and what factors they consider key to this definition. Interviews with stakeholders in the CCC Smart City Project highlighted four key aims of the project, inclusiveness, projects designed for and by citizens, participatory, and innovative. Much of the discussion with each interviewee centred on how technology could be implemented in the city to either, improve its systematic function, or improve the way citizens can interact with it. These definitions are considered ‘governmental’ in this case, as each interviewee has some connection to the Smart City Project itself. The discussion of functionality in the city was also mentioned by all four international governmental definitions, in some sense. Even here, the CCC considers smart cities as collaborative and participatory, so the definition must take this into account. Survey and focus group respondents in this research represent some users of the city, but are not considered completely representative of the population, further engagement is required to represent the views of all citizens. It is important to understand the local context of the smart city project, as smart cities must be designed for their user, residents and visitors, and therefore, the definition must represent this (Angelidou, 2015). Similar to the concept of the knowledge city, which are designed specifically for and in collaboration with the cities users, with a focus on increasing the level of knowledge of all of its citizens, and circulating intelligence throughout the city (Yigitcanlar, O’Connor, & Westerman, 2008), the smart city must aim to improve the function of the city for its people, through the use of its residents own knowledge, to drive smart technology. This can be represented by the concepts definition. HP defines the smart city well in this regard, saying;

“The smart city leverages diverse information and communication technologies to enable better business processes, help control costs, drive toward carbon neutrality, and encourage citizen interaction. This forward-looking city works to promote a healthy economy, attract people and businesses, help reduce environmental impacts,

and make it easy for citizens to participate in political, economical, cultural, and social activities.” (Hewlett-Packard Development Company, 2016, p. 1)

The research conducted supports this point. All but I04 indicated citizen engagement as a key aspect when defining the smart city, and I04 alluded to it as an end goal or measure of success of the Smart City Project. Following ‘technological’, the second most commonly discussed point when defining the smart city for Christchurch was ‘people focused’, and fourth most common was ‘informative’, both of which directly relate to the user of the city (shown in table twenty-four). This indicates that individuals perceive that smart cities will be foremost technologically focused, and this technology will be targeted at the users of the city, easy to interpret, and information about the city and the technology will be available and applicable to people. Much discussion in both focus groups concentrated on the accessibility of smart projects, for all residents of the city, meaning the success of the smart city depends on its inclusion of the city’s users, and the definition, once again, must support this.

The 2010 and 2011 Christchurch earthquake sequence are key to understanding the context of Christchurch city and future development. The effects of the earthquake sequence have been discussed, however, whether this will have an effect on the smart city concept in Christchurch needs to be analysed to understand if individuals perceive smart technology as a tool for earthquake recovery. The earthquake sequence caused a change in the structure of local communities an increase in community resilience from Christchurch residents (Berno, 2015), and a number of new physical challenges for the city, including challenges caused by the closure of schools and workplaces, the loss of residential housing and destruction of other infrastructure (Ministry for Culture and Heritage, 2017), and these changes, or new realities in

Christchurch will have an effect on future development of the city. Results from the survey in

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table twenty two, show that respondents considered “Informed and proactive approaches to natural hazard risks” as the least important of the six strategic goals of the Smart City Project, meaning individuals consider projects that will aid in reducing the negative effects of future earthquake events may be less important than other points, however, the highest rated strategic goal is “Maximising opportunities to develop a vibrant, prosperous and sustainable 21st-century city”, which relates to new projects, and post-disaster redevelopment in the city. There is obvious consideration of the redevelopment of the city as a key focus of smart cities, but less on mitigating future events. Focus groups also discussed the redevelopment of the city, predominantly through improved transport networks. Residents of Christchurch City, based on this research, consider the redevelopment of the city as central to the smart projects they mention, especially in relation to transport, with this discussion in the focus groups, and table twenty-three showing four of the five main new project suggestions from respondents of the survey involve transport including parking, public transport, cycling, and access to information about transport in Christchurch. This could be due to these projects being visible, as opposed to technology and projects affecting waste management or sensor technology, which are usually more systematic and not discussed by respondents.

Differing definitions from three separate groups, academia, business and government, and lack of consideration of the context of the city and the users in most definitions are reasons to consider re-defining the concept, especially with regard to the context of Christchurch City. The definition needs to be user-friendly, and co-created with the city’s residents, to represent the aim of the smart city as a whole. Smart cities require smart residents (Kitchin, 2014), and the definition must represent the collaboration between people and the city, co-creation and innovation, and participation in smart projects.

2.2 Proposing a new definition for the Christchurch Smart City

Redefining the smart city for the context of Christchurch City is essential, Christchurch residents have been integral to the rebuild and should be considered when developing the model for the CCC Smart City Project (Berno, 2015). Above the key reasons for this were addressed, in short, the current definitions in literature are ambiguous and do not relate to the context of Christchurch City, and do not take into account the community environment of the city. Many points in definitions of smart cities are relevant to almost all city contexts, like sustainability-focused (Höjer & Wangel, 2014), a city that optimises the use of resources available to the city (Lazaroiu & Roscia, 2012), offers an environment for business to flourish (Kitchin, 2014), optimises the basic functions of the city (Siemens, 2014), among others, however, from this research, a smart city in Christchurch City at this point in time should incorporate a number of other factors;

- 1) Community focus, incorporating community resilience, organisations, and co-creation, to influence participation in the planning of smart projects.
- 2) Technological for everyone, considering all groups of society including elderly and those with disabilities and these groups must be consulted.
- 3) Smart in design and planning, and influences smarter populations, using existing knowledge and experience of Christchurch residents as a driver for new projects.
- 4) Innovative in a post-earthquake environment, and uses technology in the future plan of the city.

The reasons for each of these have been discussed, but the way these are portrayed in Christchurch needs to be considered. As mentioned, the community is a focus of smart cities (Eteszadzadeh, 2016), and a key aspect of the Christchurch earthquake recovery process (Hayward, 2013), so making this definition accessible, and understandable to all of those in communities in Christchurch is integral in increasing engagement in The CCC Smart City Project. The portrayal of the concept must be user-friendly, like the projects themselves, and to influence participation with new smart projects in Christchurch the definition must promote an issue raised throughout the research related to safety and privacy with technology. Security, including privacy issues from hackers and access to personal information through the technology, in smart city projects has also been acknowledged in literature as an issue that needs to be addressed, as many security risks exist with increasing a cities reliance on technology, including the confidentiality of personal information (Elmaghraby & Losavio, 2014), however, in some cases has been attributed to greater security (Lazaroiu & Roscia, 2012). It must be made clear that Christchurch's smart city will aim to improve safety and security for all residents in the city.

With all points considered, the definition for Christchurch's smart city, in the context of this research, is as follows;

A Smart Christchurch City is one that incorporates its unique post-earthquake environment, strong community resilience and a high level of citizen engagement and co-creation in the city to; promote smart technological projects to all of the city's diverse citizens; support environmental and economic sustainability for future generations; optimise the use of available resources, including resident's own knowledge and expertise, in the planning and implementation of new smart projects and technology; allow business to flourish through new

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technology and innovation; and, is safe physically and supports technological security for its citizens. The technology is designed to be inclusive of all citizens, accessible and easy to understand, and promotes a smart society of people.

An initial suggestion from this research project was to attempt to suggest a definition, which has been attempted above, to encapsulate The CCC Smart City Project, and attempt to engage citizens in defining the concept further to suit their own perspectives on the city and the future development of smart projects. The CCC should consider this definition, and add to it through further consultation with citizens.

3 Community perceptions of the smart city, and their effect on behaviour change

Delving further into a significant discussion point raised throughout literature and this research, this section will discuss community perception of smart cities and the CCC Smart City Project in Christchurch. Community resilience will be discussed again, further to how it contributed to re-defining the definition of the smart city, but how it has been discussed through research by participants, and to what extent it will affect The Smart City Project. Following this, community engagement will be related to behaviour change, and suggestions will be made to acknowledge whether participation in smart projects will increase the user-ship of these projects. Finally, suggestions will be made to create meaningful data through the process of The Smart City Project in Christchurch, and how these points are applicable internationally.

3.1 Post-earthquake community resilience

Community resilience has been a common topic in this research project. Christchurch's city post-disaster recovery process has been categorised by its community resilience (Hayward, 2013), and smart cities typically rely on community resilience and engagement (Eteszadzadeh, 2016). But how can this level of community resilience be used as a driver for smart technology, or at least work in collaboration with The CCC Smart City Project? And, will the context of post-disaster Christchurch have a significant effect on the Smart City Project? In the past section, it was acknowledged that the earthquake sequence should be part of the definition for smart cities, as it is a key factor to understanding the context of Christchurch city, due to its effect on the city's infrastructure and layout, and social issues caused by displacement and the uprooting of the lives of residents (Dorahy & Kannis-Dymand, 2012) (Hogg, Kingham, Wilson, & Ardagh, 2016) (Usher-Pines, 2009). These points will be discussed further.

Will the community resilience that has been integral in shaping the Christchurch rebuild, post-disaster, have a direct effect on smart projects in the city? Typically, community organisations like The Heathcote Village Project (Heathcote Village Project, n.d) and the Student Volunteer Army (SVA) (Hayward, 2013) have concerned themselves with relieving physical distress of individuals in Christchurch communities, through small community projects, like the development of book fridges, community gardens, and small community classes, offered general relief and support services immediately after significant events, and groups with existing community structure typically found immediate recovery after the earthquake events quicker and more appropriate to their needs (Thornley, Ball, Signal, Lawson-Te Aho, & Rawson, 2015). The future of these groups, however, is becoming uncertain, with little research

focusing on the future of these community organisation. Gap Filler, for instance, has concerned itself with temporary infrastructure and projects in Christchurch (Gap Filler, n.d) to fill gaps left in the central city, as have Greening the Rubble (Greening the Rubble, n.d), and the now deconstructed Re:Start mall (Re:Start, n.d). These organisations are becoming less needed, as the completion of many permanent structures replace originally vacated land, leading to the question, will community resilience, organisations, and groups be as prevalent in Christchurch in the coming years when smart technologies are being implemented in Christchurch? From the results gathered in this project, survey respondents in table twelve mentioned ‘things to do’, and ‘events’ around town as the second and third most common features they would like to see on the SmartView application. There is a connection here between community organisation and the application, especially if the application becomes open-source meaning communities can log their own events on the application. There is an even stronger correlation between communities and smart technology when acknowledging that respondents to both surveys and in focus groups pushed community participation, and as is clear in Heathcote from the success of their community project (Heathcote Village Project, n.d), participation in community organisations and engagement with projects are generally correlated, as the Heathcote Village Project is an organisation formed post-disaster in Christchurch, with a focus on community-driven disaster resilience. Specifically, projects that are created by the residents themselves, giving the projects ownership to the community, so smart technology that has direct input and ownership from communities will have higher engagement.

The Smart City Project could use the existing community groups, and the strong nature of community resilience in Christchurch to improve their Smart City Project, through consultation with existing community organisations, and collaborations on projects. This co-creation as has been integral in Amsterdam’s smart project (Amsterdam Smart City, n.d), and in some cases

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the open innovation of technology in smart cities, considering citizens drivers of smart projects (Paskaleva, 2011), has been credit in the success internationally. Without this connection between people and technology, Paskaleva (2011) discusses that a city cannot be truly smart, rather is a wired city with well-functioning technology. Similarly, a city that has a strong focus on participatory urban design and innovation, without necessarily aiming to use technology to achieve this, rather it is achieved through the knowledge of its citizens, is often referred to as a knowledge city (KC) (Yigitcanlar, O'Connor, & Westerman, 2008). Yigitcanlar et al (2008) describe the KC as requiring "... a strong 'organising capacity' to establish such foundations with a broad partnership of public, private, academia, and community. Establishment of these foundations facilitate the development of 'knowledge industries' and 'human capital' programs which generate and attract talented workers and business..." (p. 65). The smart city can be considered at the intersection of both the wired city and the knowledge city. Using the knowledge and innovation of citizens in the city to influence and drive new technology to improve the overall function of the city, with a strong focus on transparent organisation by all agencies. In Christchurch, the smart city will be effective if consultation and engagement with communities are considered fully alongside the development of smart technology.

3.2 Community engagement and behaviour change, and how to develop meaningful data

To continue this discussion, keeping in mind the points made about the importance of community resilience in the context of the CCC Smart City Project, how can engaging communities in the planning and implementation of smart city projects lead to a change of behaviour in the users of the city? Behaviour change in this context relates to influencing the

users of Christchurch City to change the way they engage with smart projects and in turn the city, including changing the way they will access information through the SmartView application, changing the method of accessing mobility parking will be accessed through smart technology, or altering individuals use of the city, with the introduction of free CBD Wifi. The results from this research are positive in this regard, the vast majority of respondents in chapter 4, section 2.7 table twenty-five see there being no barriers to smart city projects in Christchurch, and, 89.3% and 92.9% of respondents indicated they would use SmartView and CBD free Wifi respectively. This was further affirmed through focus groups, all groups acknowledging the relevance and importance of the two projects, and indicating they would engage with these once they are fully operational. In regard to CBD free Wifi, only just over 50% of respondents indicated that this would be an incentive to use the city more, although not as convincing as the number that would use the service, this indicates a behaviour change could occur in relation to the use of the city, with the proper planning and implementation of the project. Further to this, respondents mentioned a number of ways in which to improve smart projects and new projects that would be of benefit to them, and with further consultation, respondents in the focus groups indicated they would be more inclined to use smart projects, and change the way they use the city overall.

The evidence from the survey respondents discussed in the above paragraph is supported by the literature. The debate between top-down and bottom-up approaches in smart city literature is prevalent (Smedley, 2013). On one hand, smart cities are built top-down planning through sensors, big data, transport planning, and decisions made by experts at the top, on the other you have community projects, innovation, and co-production as discussed previously as bottom-up development. IBM's smart city report in Christchurch (2013) is an example of top-down smart city planning. They offered suggestions based on international examples, and an assessment of

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Christchurch systematically to provide recommendations to the CCC to implement smart technology, with little consultation of citizens in the city. In many examples this process has been successful, but is typically followed by the utilisation of human capital in the city, for instance in Singapore where the government planned education in technology, with the intent to foster innovation in its citizens (Smart Nation Singapore, 2017), however in the case of IBM in Christchurch (IBM, 2013), little was achieved even given the research conducted. This research suggests this could be complemented with a bottom-up approach, as seen in Amsterdam, with the cities citizens driving a large number of the smart projects in the city (Amsterdam Smart City, n.d), to improve the overall engagement in smart technology. Current smart technology in Christchurch has been top-down fully. In the stakeholder interviews conducted, smart projects acknowledged either had a direct influence on the function of Christchurch and had involved consultation with experts, for instance, earthquake monitoring and seismic sensor technology to quickly assess the effect of earthquake events on infrastructure, or were internationally recognised smart projects like the city dashboard, SmartView. As mentioned, this type of top-down implementation is not inherently negative, but community consultation and engagement will likely mean these projects will be a success.

This level of engagement, however, has been acknowledged as a challenge, specifically in examples from the European Union (Paskaleva, 2011). This relies on a partnership of not just governments and users of the city, but businesses also. Creating smart citizens who, like in a knowledge city (Yigitcanlar, O'Connor, & Westerman, 2008), understand smart technology, drive innovation in the city, and seek knowledge to engage in the planning process of smart cities will aid in this. Governments and businesses will typically engage due to financial prospect, but residents of the city need to understand the technology, and how engagement will improve the city. "... creating a digital community with smart citizens and smart developers is

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the main instrument for achieving the goals to create new, dynamic relationships in the smart city.” (Paskaleva, 2011, p. 161). Key to this is understanding the context of the city’s residents, what they care about and how they use the city, and supporting new projects that this group considers important. Going back, Christchurch has the opportunity, with its strong community resilience, to engage specific community organisations and groups, and involve them directly in the planning process of smart cities. Discussion in the focus groups conducted showed participants were interested in the idea of Christchurch becoming a smart city, and the wish to engage more in this process, however, other than from my research, none of the participants had previously heard the term smart city or knew of the CCC Smart City Project. Consultation can create awareness in smart technology and the project as a whole, however, engagement requires the users of the city to feel included in the process, and like they are making a difference (Paskaleva, 2011).

Meaningful data is information that will be generated through the CCC Smart City Project which will have an influence on the stakeholders of the city, like information that can advise businesses on the financial situation of the city, or advise citizens of parking locations, and engagement will improve access to this information. In the context of this research meaningful data is considered useful by the target audience and is easy to use to improve smart projects in the city. This is not to say data that citizens do not engage with directly, like water quality measurements, are not meaningful, rather there needs to be a purpose to gathering the data for some stakeholder. Meaningful data is integral to assess the success of smart projects, offer information about potential new projects and will be beneficial directly to the stakeholders of the smart city project. How this data will be received and distributed must be considered, and community and residents in the city must be made aware of this data. London’s city dashboard shows a number of features from sensors around the city (CASA, n.d), the data is displayed in

a user-friendly way, as discussed above, promoting engagement with this project. SmartView is showing similar information, including water quality and UV information from sensors (Christchurch City Council, 2018). However, as discussed, an issue common with respondents was security and safety issues caused by smart technology. What will be key to creating meaningful data through the Smart City Project, will be communicating the information in a user-friendly manner for all groups in society and to ensure the data gathered is safe and secure. Mentioned numerous times throughout this project is the importance of accessibility of smart projects, especially for minority groups like elderly, those with disabilities, and generally those with less knowledge about technology. The CCC must consider how to make this data accessible to support engagement from a diverse number of groups. Smart mobility parking solutions is a key project in this respect, and understanding ways in which individuals currently engage. Mobility parking only affects a minority proportion of Christchurch's population, but the service is integral for this group to be able to effectively get around Christchurch City. With the advent of technology aiming to improve the system of mobility parking in Christchurch, engagement with the individuals who will be using this parking infrastructure will highlight issues that should be considered. Section 2.6 of chapter 4 in this thesis report shows results from the survey, of individuals who use, or know of others that use, mobility parking in Christchurch. A number of issues were raised that require consideration. The majority of individuals acknowledged that mobility parking was not adequate to some extent, to the needs of them or someone they know (table 18) and the main reasons was the low frequency of parks available, and the location of parks and their access to other areas and availability of information about mobility parking were both considered poor (table 19). Further engagement with the elderly and disabled community in Christchurch will further elaborate on this issue, and the CCC and smart city projects must consider these minority groups in the planning of smart projects.

4 Suggestions for the Christchurch City Council's Smart City Project, and smart city projects internationally

A specific aim of this research project was to offer suggestions to the Christchurch City Council about how to improve their smart city project, specifically the level of community engagement in the project, and identify techniques for similar smart projects internationally. This section will discuss how this was achieved through the research process, and discuss a number of key findings, including; the Smart City Strategic Goals and whether they adequately address the perceived goals of residents in Christchurch; how to promote participation in Christchurch, and future steps for the Smart City Project; and recommendations for smart city projects internationally, specifically when engaging communities.

4.1 The CCC's Smart City Strategic Goals

The Christchurch City Council outlined six strategic goals for the smart city project. These are;

- 1) Enabling active citizenship and connected communities
- 2) Maximising opportunities to develop a vibrant, prosperous and sustainable 21st-century city
- 3) Climate change leadership
- 4) Informed and proactive approaches to natural hazard risks
- 5) Increasing active, public and shared transport opportunities and use
- 6) Safe and sustainable water supply and improved waterways

These are important in understanding the direction of the Smart City Project in its current state. Smart projects currently being trailed or planned aim to address one or more of these goals. Similarly, international smart cities set goals like these, Amsterdam focuses on seven themes when designing projects, and these are; Infrastructure and Technology; Energy, Water and Waste; Mobility; Circular City; Governance and Education; Citizens and Living; and the Smart City Academy (Amsterdam Smart City, n.d). A number of crossovers seem to exist, like citizen focus, water and governance, yet the focus of each seems tailored to each specific city.

Survey respondents were asked to indicate which of these they considered most important. Seen in table twenty-two and figure twelve, “Maximising opportunities to develop a vibrant, prosperous and sustainable 21st-century city” and “Increasing active, public and shared transport opportunities and use” were the first and second most important goals for respondents respectively. “Informed and proactive approaches to natural hazard risks” was ranked the lowest. This is an important point to raise, as discussed smart cities rely on their citizen's participation and knowledge, and engagement is key to achieve this, so understanding what citizens in Christchurch value highly in planning will be integral in planning future projects. Interestingly, the second highest goal for participants relates to transport in Christchurch. This relates to table twenty-three, which displays the majority of the most common new projects suggested by respondents related to transport, including parking initiatives and public transport improvements. On top of this, a predominant area of discussion of both focus groups was transport. Little research acknowledges transport as a key aspect of the smart city, some have attributed good mobility in the city as a product of smart projects (Lazaroiu & Roscia, 2012), and however, it seems more prominent in consultation with Christchurch citizens. This research suggests The Smart City Project focus on transport as it has been a central point of discussion since the Christchurch Earthquake sequence (Ministry for Culture and Heritage, 2017). The

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loss of infrastructure in the events caused mass displacement, and a huge stress on transport networks in Christchurch (Hogg, Kingham, Wilson, & Ardagh, 2016). This is yet to be addressed, so is an opportunity for smart planning initiatives to shape the transport redesign of the city. Again, engagement with involved communities is integral in understanding the full extent of transport issues in Christchurch and should be considered foremost by the CCC. Finally, the most important goal for respondents was “Maximising opportunities to develop a vibrant, prosperous and sustainable 21st-century city” and the least “Informed and proactive approaches to natural hazard risks”. The CCC should look at active solutions to improve the city, respondents seem less focused on using smart technology to protect against future natural hazards, like earthquakes, and would rather see new technology used in different ways to the regular.

As a final point, these goals have been created through the CCC Smart City Project, but, involve little consultation with communities. To ensure the goals of the project meet the needs of the community, the process of engagement should break down the barriers of government and community tensions (Hayward, 2013), allowing the plan for the smart city to be decided in collaboration with both organisations. Once again, as discussed in a large amount of detail throughout this report, this level of engagement will influence participation from the community in the Smart City Project, which in turn will create meaningful data and change the behaviours of citizens in Christchurch.

4.2 Next steps of the research: How and who to engage to foster participation in The CCC Smart City Project, and internationally

It is clear that engagement will be integral to the Smart City Project overall in Christchurch, but how can the CCC properly and appropriately influence engagement with the project? Again, community organisations should be targeted to understand the perceptions of citizens, but typically these organisations operate within areas with engaged individuals, where areas with less engagement would be the target of smart city consultation. These groups will benefit from smart city technology immensely, so attempting to understand how to engage them appropriately is integral. Following this, groups discussed in this research project, including elderly and those with disabilities will provide insight into the use of the city of these groups. This research has predominantly focused on circulation through online Facebook community groups, meaning these individuals are typically well engaged in CCC affairs, as well are in a group of society that is overrepresented in CCC decision making. It will be important going forward for the CCC to avoid falling back on this group for consultation, as they would run the risk of developing smart projects only for a specific group in society who may not need the services offered through these projects or may need different services. Improving technology in the city will offer solutions to many issues relating to the use of the city for the groups affected by these issues are consulted, as discussed with elderly populations and those with disabilities and their use of mobility parking in Christchurch.

Issues raised through research include; safety and security concerns in new smart technology; current transport issues in the city; and the cost of the smart city. A number of other issues for diverse groups in the city are likely to exist, that were not mentioned in this research, due to

the limited response rate, and demographics of respondents, for instance, consulting individuals who are not involved in community organisations may show different issues with smart technology and projects. The cost of the smart city was mentioned a number of times throughout the research process, from survey respondents in section 2.7 of chapter 4, specifically table twenty-five, but more specifically by focus group respondents in section 3 of chapter 4. This issue is one that requires participation to mitigate, with smart city technology having the capability to reduce costs in the city (Höjer & Wangel, 2014; Kitchin, 2014), but in this research, smart technology is seen by many as an extra cost to be absorbed by citizens. By increasing engagement through participation in the research, this point can be made clear to residents, increasing support and willingness to engage in smart technology.

The continued participatory research will improve the validity of the results gained through this thesis project. Ongoing engagement, as has begun through this project, will highlight issues of the smart city project, and offer solutions to these. It will be important for this participatory research to consider participants, or citizens as co-researchers in the process, as opposed to simply respondents (Bergold & Thomas, 2012). Bergold and Thomas (2012) also discuss, that participants opinions must be considered with respect to expert evidence, and again, the diversity of voices in Christchurch, and the research must be ongoing, participants should be consulted during planning, implementation and evaluation stages of projects, and follow up research in the future should assess the overall engagement process, to improve and develop it for future participatory research. In the CCC Smart City Project, participatory research could start with the engaged community groups but will need to consider how to engage minority groups and those typically un-engaged in Council process. As well, this process of participation will lead to new ideas and expertise in the smart projects.

Outside of the CCC Smart City Project, international smart cities, and other national examples need to consider how best to begin participatory engagement with the cities citizens. Considering existing community groups, and distinct demographic groups in the city will allow smart projects to support the needs of all citizens. The situation of citizens being engaged should be considered in the context of each individual city.

5 Limitations and further research

A number of limitations in this research project exist, that if mitigated, will provide further suggestions and information to the CCC Smart City Project and smart city projects internationally. The research methodology employed in the project has been appropriate to understand perspectives of some stakeholders of the smart city project, however, further analysis is required. This research offers a platform for participatory research, however, true participatory research must be ongoing (Kindon, 2005) (Pain & Francis, 2003). Businesses involved in technology in Christchurch need to be consulted, and a broader assessment of governmental and user perspectives are required. The type of research should be expanded, to increase engagement of diverse age brackets, those with disabilities, varying socio-economic groups, and a more representative group of ethnicities. The Christchurch City Council's influence in Christchurch also needs to be understood to increase the overall engagement. This section will discuss these issues and make suggestions for further research in Christchurch and internationally.

5.1 Research methods

Three key points relating to the research methods employed in this project require addressing. The research methods themselves are not an entirely adequate form of consultation going forward in The Smart City Project, the overall level of engagement was low and made it difficult to draw substantial conclusions, and through the research process new ideas to improve the methodology were raised, and issues with the implemented research were discovered. A fourth issue that was acknowledged, is the under-representation of a number of demographic groups in Christchurch, to be discussed further in this chapter.

This project involved stakeholder interviews, a community survey and two focus groups, with an aim to understand specific community perspectives of the CCC Smart City Project. This involves two of the key stakeholders in the project, the governmental agency, and the citizens of the city, but neglects to acknowledge a key group in the planning of smart cities, discussed in many international examples like Singapore (Smart Nation Singapore, 2017) and Barcelona (Barcelona City Council, 2017), being the influence of technology industries in the city. In Christchurch, a number of technology and innovation focused organisation are in operation, including the Vodafone Xone Start-up Accelerator (Vodafone, 2018), Epic Innovation (Epic Innovation, 2017) and the Innovation Precinct (Innovation Precinct Christchurch, 2018). These organisations, among many others, have a focus on either innovation, technology, or a combination of the two, and will have a vested interest in the CCC Smart City Project, or further to that, could be a driver in a number of smart projects. These groups require consultation and engagement to understand the context in which the Smart City Project in Christchurch will be operating, as well engagement in the planning and implementation of

projects. In this research, an attempt to reach out to these organisations was made, with a copy of the community survey being sent specifically to these, and other, organisations. This was sent as a separate survey to assess whether individuals involved in these organisations would have differing opinions to general community members. However, this only received one response. The method of circulation to the contact email address of each organisation needs to be targeted more specifically to each organisation to increase engagement.

The overall level of engagement in each research method was low, in relation to the population of Christchurch, although the research shows a number of key insights that will aid in The CCC Smart City Project and smart city projects internationally, addressing this point is important for future research. To improve the results from stakeholder interviews, further engagement with CCC employees is required, and follow up interviews would provide insight into the ever-changing Smart City Project. Similarity, increasing the number, consistency, and diversity of focus groups would provide deeper insight into why citizens feel certain ways about smart city projects, especially going into the future when smart projects become common around the city, and the project itself becomes common knowledge to citizens. On top of this, promoting diversity in these groups, and surveys is important to understand a number of different perspectives on smart projects and technology, and this will be discussed further in the next section. The surveys received 112 respondents all through the digital survey. As mentioned, 75 more responses were unfinished. To understand the reason for participant's uncompleted surveys would be beneficial for future surveys. Further, promoting more survey mediums, including face-to-face surveying and mail drops could have increased the number of respondents, and follow up surveys will be integral in displaying the change in perception of smart cities as new technology is introduced to the city.

Finally, throughout the research project, a number of issues were raised with the methodology that should be mitigated for future research. The stakeholder interviews were conducted initially, to understand the background of the Smart City Project in Christchurch, however, conducting these after the survey and focus groups would have allowed insight gained from respondents to be discussed with the individuals directly involved with the project, and questions that respondents had, to be asked to the interviewees. This would allow for secondary follow up focus groups and surveys answering initial questions and concerns of the smart projects. Also, regarding the survey, respondents who indicated they were residents of Christchurch were asked for their home suburb, and this information had been intended to show differing opinions on smart city concepts geographically, as briefly discussed in section 2.8 of this report. This, came up inconclusive due to a number of reasons. First, suburbs were pre-determined in the survey, based on a dataset retrieved off of the internet, and this did not include all suburbs, and as the 'other' option of this question did not require a text entry to support it, a large proportion of people who answered 'other' invalidated the data. This is still an important point to attempt to understand, and in future research it would be suggested to break up the Christchurch area more broadly, potentially by socio-economic information gathered through the census, or proximity to the central city, to attempt to understand if economic inequality or distance to the central city would affect individuals perspective of smart technology in Christchurch.

5.2 Demographic and engagement, and participation in a Christchurch City Council project

This research took a sample of Christchurch City's population to understand community perceptions of the Smart City Project, yet as discussed above, the level of engagement could be increased, and improving this would yield significantly more certain results about community perceptions of smart city projects. Specifically, attempting to engage a diverse proportion of Christchurch's population is integral to appropriately engage citizens in the smart project. Especially groups that are typically unengaged with technology in the city, and generally less engaged with CCC, like lower socio-economic groups, young and old generations, minority ethnicities, and in the case of this research, males and alternative genders.

There is distinct lack of respondents in a number of demographic categories shown in section 2.1 of chapter three, and tables three, four, five and six. Over 70 percent of respondents identify as a female, and under 2 percent as neither male nor female. To improve the quality of this research, an even number of males and females would offer more general results and a better comparison of gender perspectives of smart cities. Also, more participation from those who identify as other genders would offer a traditionally overlooked perspective on the design of the city and smart projects, although this should be better defined, offering individuals the opportunity to express how they define their own gender. Also, close to 75 percent of participants were below the age of 35, meaning there is a distinct over-representation of young people in this survey. This could be due to the method of circulation, as younger generations typically have access to the internet and computers, whereas many in older generations do not (Statistics New Zealand, 2012). Attempting to engage elderly generations in future research is

key to making the smart city accessible to all. There is an underrepresentation of Māori and Pacific peoples compared to the 2013 New Zealand census in this piece of research, where this research reached 5.4 percent and 0.0 percent Māori and Pacific respectively, and the census 14.9 percent and 7.4 percent of the population is Māori and Pacific. Engagement with these groups could have been low once again due to the method of survey circulation, or the community group pages it was posted on. This is an issue that requires more thorough consultation. Finally, close to a third of respondents hold a bachelors degree, and close to another 30 percent masters, honours or postgraduate degrees, meaning the majority of the respondents have higher education. There needs to be more focus on lower education levels, as mentioned a number of times that education in technology is an important factor of the smart city. Future research should look at solutions to engage these groups to further validate claims made in this report.

Christchurch's population is made up of a number of diverse groups, including many with different disabilities. The discussion on mobility parking is a small but important discussion to have, and requires specific consultation, with individuals that will be using the service especially, and from the results in this report a fair number of important points were raised, however, the majority of respondents indicated they were elderly, meaning the many varying groups with specific disabilities who will use this service were underrepresented. On top of this, consultation with these groups cannot be a blanket process, the variety of disabilities experienced by citizens in Christchurch means consultation will have to be considered carefully to cover all groups appropriately. This was outside of the scope of this research but is a suggestion for the CCC going forward to address.

An issue mentioned a number of times in the focus groups, and general consultation including the stakeholder interviews, was the distrust communities feel toward the CCC. This attitude can affect the level of engagement from citizens in new CCC projects like the Smart City Project. This project was met with a number of barriers, including individuals wishing to not take part in the research, or discussion of points not relevant to smart cities, rather concerns of the individual about the City Council generally. This did not pose too much of an issue for the purpose of this research, however, going forward the CCC must recognise this will be a reality when consulting about the smart city project.

Chapter 6: Conclusion

1 The smart city

This thesis project has analysed the concept of smart cities, The CCC Smart City Project, and case studies nationally and internationally, to understand community perspectives of smart technological projects in the city. It offers a platform on which to conduct further research in the field of smart cities internationally, addressing a gap in current smart city literature, where community participation is discussed as an integral aspect of the success of smart cities (Eteszadzadeh, 2016), and is used internationally as a driver for smart projects. However, there is a paucity of literature that discusses how to engage communities and citizens in smart city projects. Further, the definitions of smart cities outlined in the literature are widely debated, with three distinct groups showing a vested interest in smart cities and smart technology and defining the concept differently, namely academics, business organisations like IBM and Siemens (IBM, 2013; Siemens, 2014), and governments respectively. This conclusion section will summarise and offer conclusions of the key findings from the literature review, the methodology, results and discussion in this report. It will outline the key findings and future research suggested to further address the aim of this project; to suggest ways to create actionable and meaningful data for residents and visitors in the city from the information gathered in Christchurch's Smart City Project.

The review of current smart city literature highlighted the various definitions of the smart city. These definitions have a historical context, with the first smart city concepts being discussed as early as the late 19th century, aligning with the first developments to the city with a focus on technology (Angelidou, 2015) and the term smart city first being coined during the 1990's (Höjer & Wangel, 2014). As mentioned, the debate between academics, businesses and

governments on the definition of smart cities blur the understanding of the topic in its current state (Marek, Campbell, & Bui, 2017), academics typically see smart cities as a city that utilises technology to its fullest extent to improve the overall function and efficiency of the city (Eteszadzadeh, 2016), and one where the ‘knowledge economy’ is supported, meaning it is made smart through having a smart society with a focus on innovation (Kitchin, 2014). This is not entirely dissimilar to organisations, specifically, technology and innovation focused businesses in the private sector, although they tend to focus on smart technology as a driver for economic gain, and not surprisingly see economic opportunity in smart projects (Cisco, nd; Hewlett-Packard Development Company, 2016). Governments also consider points similar to the above two groups, however, traditionally focus more on the citizens of the city, the users of smart projects, arguably the key stakeholders in smart projects everywhere. Again, Amsterdam exhibits this in practice, promoting open sourced, community-driven smart projects to enhance the quality of technology in the city (Amsterdam Smart City, n.d). In this project, a definition of the smart city in the context of Christchurch has been offered. Taking into account the context of Christchurch city, including the 2010 and 2011 Christchurch Earthquake sequence, community resilience generated from this and post-disaster recovery generally, as well academic and international examples of smart cities, and the perspectives of individuals consulted in this research project, the following definition was created;

Christchurch as a smart city is one that uses its unique post-earthquake environment, strong community resilience and a high level of citizen engagement and co-creation in the city to; promote smart technological projects to all members of the city’s broader society; support environmental and economic sustainability for future generations; optimise the use of available resources including human resources in the planning and implementation of new projects; allow business to flourish through new technology and innovation; and, is safe physically and

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promotes technological security to its citizens. The technology is designed to be inclusive of all citizens, accessible and easy to understand, and promotes a smart society of people.

The methodology employed in this research project has provided initial steps for participatory research in The CCC Smart City Project, and similar projects internationally. It consisted of four stakeholder interviews with CCC employees engaged with the Smart City Project, a community survey of 112 residents, and two focus groups. Questions focused on defining smart cities, current smart projects, new projects, issues and concerns with smart technology, and techniques for engagement. Quantitative results from the survey were analysed through Microsoft Excel and qualitative through NVivo software and displayed via a series of graphs and tables. Observations were described and the key finds were discussed. The focus group and interview results were discussed as a series of key findings, to be compared to each other, and results from the survey and literature review. The key findings were as follows; smart cities require active engagement with communities; the definition of smart city in the context of Christchurch must be revised, as discussed above; smart city technology must be defined for the benefit of all citizens in the city, taking into account minority groups, like the elderly, children, minority ethnicities, those with disabilities, and others; awareness of the project must be improved; the safety and security of smart technology is an issue for many, and should be addressed; transport issues are common when discussing new projects in Christchurch, potentially due to the earthquake sequence, and projects improving parking, cycle ways, public transport, and mobility parking have been discussed in detail; participants in the research indicated they would not be willing to pay more for smart projects, so influencing and promoting the cost saving benefits of smart projects is crucial; to influence behaviour change from smart projects, citizen engagement must be the focus of The Smart City Project, and pulling examples from international cases like Amsterdam and Singapore will provide a solid

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foundation to achieve this (Amsterdam Smart City, n.d) (Smart Nation Singapore, 2017), while considering the context of Christchurch city; successful smart cities must consider their citizens a driver of smart technology, the technology itself is not the enabler, a smart society driving innovation is key; other national and international smart projects must consider engagement in their project, and using techniques employed in this research can offer a starting point for increasing this level of engagement; and finally, engagement with community groups, and technology and innovation focused business in Christchurch must be conducted to further understand perspectives and the context of the smart city with Christchurch.

Further research is required to fully understand how to effectively engage citizens in the CCC Smart City Project and projects internationally. Research should first understand the context of the city, including the demographics of citizens, communities groups operating in the city, any major events that have affected the city like the Christchurch Earthquake Sequence, and all stakeholders in smart technology, business, academia, and the citizens themselves. Following the steps in this research project will lay the base for participatory research and engagement in smart city projects. This research has shown that key to actionable and meaningful data in Christchurch is engagement, literature has described this theme in detail, as has consultation with residents in Christchurch. As a final remark, The CCC Smart City Project's next step must be engagement with community, as mentioned this could be achieved through consultation with the vast number of community organisations in Christchurch, as well engaging businesses involved in the technology and innovation sector should be considered, to support the knowledge economy of Christchurch and the development of smart projects and the urban environment of the city generally.

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Appendices

1 Appendix 1

Interview section	Topic	Question	Key points
(1) Introduction	<p>Thank for meeting. Set up recorder. Ask if they mind it being recorded.</p> <p>Name and who I am, project description, consent form, should take up to 1.5hours.</p> <p>Discuss why I am doing this research, that they are being interviewed in their role at the council specifically, and most questions are related to your opinion of the project. Tell them why I need to understand this, to inform my methodology and own understanding of the project.</p>		

	Mention they can have access to my data if they wish. Attached to the consent form.		
(2) Role and background questions	<p>Their role at CCC.</p> <p>Their role in/relationship to the Smart City Project.</p>	<p>What is your role at the CCC?</p> <p>Their role in/relationship to the Smart City Project</p>	<p>Role, position, what their involvement in the project is, what they have done so far.</p>
(3) Project objectives/outcomes	<p>Outcome</p> <p>Challenges/barriers</p>	<p>What are the intended outcomes of your part of the project/What would you expect to see from the project, from your position?</p> <p>What could the outcomes be for society?</p>	<p>Goals, plans for Christchurch</p> <p>If they might know</p>

	Measure of success	What challenges or barriers are you facing currently?	Specific hurdles
	Usefulness for Christchurch	<p>What could be future challenges/barriers?</p> <p>How will you know that you have been successful?</p> <p>What are the outcomes more specifically for Christchurch;</p> <p>Of your part of the project?</p> <p>Of the project as a whole?</p>	Key determinant

(4) Smart city details and definitions	Definition of smart city	In your own words, could you define what a smart city is?	Solid definition, reiterate this.
	Application in Christchurch	What is being done (to your knowledge) in the smart city project in Christchurch?	Specific projects, examples, places, etc.
	Citizen engagement	What citizen engagement is happening to your knowledge currently?	
		Is there any point to citizen engagement in your part of the project/in the project?	Try to get a yes, probe to what it could achieve.

		<p>How could citizens be better engaged in the project?</p> <p>Who could be engaged better in your opinion?</p> <p>Do you think behaviour change would be affected by engagement? How?</p>	<p>In any parts. What are they doing currently?</p> <p>Groups, demographics, etc.</p> <p>Ie. More people using smart tools, more involvement in planning. Etc.</p>
(5) Further work in my project	Current research questions and objectives	Could I add anything to my current research aims or objectives?	For their work. For my own.

		<p>Could I do anything specifically to achieve my aims, and engage citizens in the Smart City project?</p> <p>What would be useful for you from my research?</p>	
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2 Appendix 2

Christchurch City Technology Projects - Community Survey

Start of Block: Information form

Q1 Generating actionable and meaningful data from a Smart Cities project

Hayden Slaughter – Masters of Science thesis project

My name is Hayden Slaughter, I am a Masters of Science thesis student, majoring in Geography at The University of Canterbury. My research project involves understanding community perceptions of projects currently being trialled by The Christchurch City Council's Smart Cities Christchurch Programme.

This survey will take between 10 and 15 minutes, and asks you questions about your opinion on some projects around Christchurch, currently being trialled by Smart Cities Christchurch, and asks for your input into these projects and any others that you think could be beneficial to the City, and yourself.

A smart city is one that uses new technology-driven projects to improve the way the city can be used by people. This could be through improving access to information about the city, helping people to find car parking, offering city-wide free wifi, reducing the number of overflowing bins on streets, creating maps displaying large amounts of information about the city, and many other projects similar to this. Smart cities aim to improve the function of the city for its citizens.

For more detailed information about the project, please contact Hayden Slaughter at hayden.slaughter@pg.canterbury.ac.nz.

This survey is only for individuals over the age of 18.

These projects are part of The Smart Cities Christchurch Programme. For more information, see this two-minute video here: <https://www.youtube.com/watch?v=FB1RuTRLQCM&feature=youtu.be>
Click next to continue to the survey.

End of Block: Information form

Start of Block: Consent

Q53 By continuing this survey you agree to the following:

Results will be used to support my research if you wish to pull out you can at any time.

All results will be kept confidential to me, the supervisors of my thesis, and the City Council. No personal information provided will be included in the research.

The results may be published and will be released in the form of my thesis.

I have been given a full explanation of this project and have had the opportunity to ask questions.

I understand what is required of me if I agree to take part in the research.

I understand that participation is voluntary and I may withdraw at any time without penalty by simply closing the browser window, once submitted, you can not withdraw from this research as your response will be confidential.

I understand that any information provided will be kept confidential to the researcher. No personal information will be used to identify me in any part of the research.

I understand all information provided will be kept securely by the researcher.

I understand the risks associated with taking part and how they will be managed.

I understand that the raw data, with the exception of personal details, will be made available to the Christchurch City Council.

I understand that no personal information will be shared with the Christchurch City Council.

I understand that I must be over the age of 18 to complete this survey.

I understand that I can contact the researcher Hayden John Slaughter hayden.slaughter@pg.canterbury.ac.nz or supervisor Dr Malcolm Campbell, who can be contacted at malcolm.campbell@canterbury.ac.nz.

If I have any complaints, I can contact the Chair of the University of Canterbury Human Ethics Committee, Private Bag 4800, Christchurch (human-ethics@canterbury.ac.nz)

Email me if you have any further inquiries.

Q54 Are you over the age of 18, and do you agree with the above terms and wish to participate in this survey?

☐ Yes (1)

☐ No (2)

Skip To: End of Survey If Q54 = No

End of Block: Consent

Start of Block: General Questions

Q3 Are you a Christchurch Resident?

☐ Yes (1)

☐ No (2)

☐ Other (3) _____

Display This Question:

If Q3 = Yes

Q18 What suburb do you live in?

▼ Addington (1) ... Other (140)

Q4 How do you access information about Christchurch city? (Tick all that apply)

- ☐ Internet/Google search (1)
 - ☐ Christchurch City Council website (2)
 - ☐ Other website(s) (3)
 - ☐ Social media (Facebook, Instagram, Twitter etc) (4)
 - ☐ Word of mouth (5)
 - ☐ Mobile phone application (6)
 - ☐ Newspapers, magazines, or other publications (7)
 - ☐ Information boards around the city (8)
 - ☐ I don't (9)
 - ☐ N/A (10)
 - ☐ Other (Please specify) (11) _____
-

Q6 What is your main form of accessing information about Christchurch city? (Tick ONE ONLY)

- ☐ Internet/Google search (1)
 - ☐ Christchurch City Council website (2)
 - ☐ Other website(s) (3)
 - ☐ Social media (Facebook, Instagram, Twitter etc) (4)
 - ☐ Word of mouth (5)
 - ☐ Mobile phone application (6)
 - ☐ Newspapers, magazines, or other publications (7)
 - ☐ Information boards around the city (8)
 - ☐ I don't (9)
 - ☐ N/A (10)
 - ☐ Other (Please specify) (11) _____
-

Q5 Could the way that you access information about Christchurch city be improved/simplified for you?

- ☐ Yes (Please specify how) (1) _____
 - ☐ No (2)
-

Q8 What is your usual mode of transport around Christchurch City?

- ☐ Car (drive myself) (1)
 - ☐ Car (driven by someone else) (2)
 - ☐ Bus (3)
 - ☐ Bike (4)
 - ☐ Walk (5)
 - ☐ Skateboard/Scooter/Rollerblade (6)
 - ☐ Taxi/Uber (7)
 - ☐ Other (Please Specify) (8) _____
-

Q9 What other modes of transport do you use around Christchurch City?

- ☐ Car (drive myself) (1)
- ☐ Car (driven by someone else) (2)
- ☐ Bus (3)
- ☐ Bike (4)
- ☐ Walk (5)
- ☐ Skateboard/Scooter/Rollerblade (6)
- ☐ Taxi/Uber (7)
- ☐ Other (Please Specify) (8) _____

End of Block: General Questions

Start of Block: City Dashboard

Q39 City dashboards are website applications that contain information about Christchurch, including a map with information including transport routes and times, car parking, cycleways, construction, as well, provide details including, tourism details, environmental information, events, and earthquake information. These can also use crowd-sourced information, meaning residents and communities can add details about their own neighbourhoods and the city.

Q13 Would you use a website or app, similar to Google Maps, that displays information about Christchurch City?

☐ Yes (1)

☐ No (2)

☐ I don't know (3)

Q19 Would you wish to add information from your own personal experience in Christchurch to this map?

☐ Yes (1)

☐ No (2)

☐ I don't know (3)

Q20 If Christchurch city had an online map that displayed information about the city, like Google Maps but more specific to Christchurch, what information would you like to see on it? Comment in the box below.

Q21 How interested would you be in using a website or mobile application like this, that allowed you to view information about Christchurch collected from a variety of sources?

A great deal	A lot	A moderate amount	A little	Not at all	
0	1	2	3	4	5

Interest level (1)



End of Block: City Dashboard

Start of Block: City Wifi

Q40 Smart Cities Christchurch is considering implementing central city free Wifi in Christchurch.

Q23 Would you use a free Wifi service in Christchurch's Central City?

- ☐ Yes (1)
 - ☐ No (2)
 - ☐ I don't know (3)
-

Q24 To what extent would you use a free Wifi service in Christchurch's Central City?

- ☐ A great deal (1)
 - ☐ A lot (2)
 - ☐ A moderate amount (3)
 - ☐ A little (4)
 - ☐ None at all (5)
-

Q26 Would central city free Wifi be an incentive for you to come into Christchurch central city more often?

- ☐ Yes (1)
- ☐ No (2)
- ☐ I don't know (3)

End of Block: City Wifi

Start of Block: Mobility Parking

Q43 Smart Cities Christchurch is also working on making mobility parking more accessible to users. This means having sensors to tell you where parks are, and if they are available, and sensors that link between mobility parking permits, and the parks themselves. This will make these parks more user-friendly and improve the functionality in the city.

Q31 Have you, or someone you know closely, used mobility parking in Christchurch's central city?

- ☐ Yes, I have personally (1)
- ☐ Yes, someone I know closely has (2)
- ☐ No, or I am unsure (3)
-

Display This Question:

If Q31 = Yes, I have personally

Q32 How often do you use these parks in the central city?

- ☐ Daily (1)
- ☐ 4-6 times a week (2)
- ☐ 2-3 times a week (3)
- ☐ Once a week (4)
- ☐ Once a month (5)
- ☐ Only a couple of times in total (6)
- ☐ I don't know (7)

Display This Question:

If Q31 = Yes, someone I know closely has

Q34 To your knowledge, how often does this person use these parks in the central city?

- ☐ Daily (1)
- ☐ 4-6 times a week (2)
- ☐ 2-3 times a week (3)
- ☐ Once a week (4)
- ☐ Once a month (5)
- ☐ Only a couple of times in total (6)
- ☐ I don't know (7)

Display This Question:

If Q31 = Yes, I have personally

Q33 Do you agree or disagree that current mobility parking in Christchurch's central city is adequate for your needs?

- ☐ Strongly agree (1)
- ☐ Agree (2)
- ☐ Somewhat agree (3)
- ☐ Neither agree nor disagree (4)
- ☐ Somewhat disagree (5)
- ☐ Disagree (6)
- ☐ Strongly disagree (7)
- ☐ I don't know (8)

Display This Question:

If Q31 = Yes, someone I know closely has

Q35 To your knowledge, does this person agree or disagree that current mobility parking in Christchurch's central city is adequate for their needs?

- ☐ Strongly agree (1)
- ☐ Agree (2)
- ☐ Somewhat agree (3)
- ☐ Neither agree nor disagree (4)
- ☐ Somewhat disagree (5)
- ☐ Disagree (6)
- ☐ Strongly disagree (7)
- ☐ I don't know (8)

Display This Question:

If Q31 = Yes, I have personally

Or Q31 = Yes, someone I know closely has

Q36 How would you improve mobility parking in Christchurch's Central City?

Display This Question:

If Q31 = Yes, I have personally

Or Q31 = Yes, someone I know closely has

Q37 Would you be interested in a mobile application that displays information about mobility parking around the city, allows you to comment and rate mobility parking from experience, and report issues directly to the Christchurch City Council?

☐ Yes (Please indicate why) (1) _____

☐ No (Please indicate why) (2) _____

End of Block: Mobility Parking

Start of Block: New Projects

Q27 Thinking about all of the projects we have talked about so far (City Dashboards, Wifi), what additional projects or technology would you add to Christchurch City? Why?

Q46 In your own words, what would a smart Christchurch look like to you?

Q47 Do you have any concerns or see any risks with the Christchurch adopting the Smart Cities approach?



Q48 The following are the strategic goals of the Smart City Project, please rank each from 1 to 6, 1 being the most important to you, and 6 being the least.

- _____ Enabling active citizenship and connected communities (1)
- _____ Maximising opportunities to develop a vibrant, prosperous and sustainable 21st-century city (2)
- _____ Climate change leadership (3)
- _____ Informed and proactive approaches to natural hazard risks (4)
- _____ Increasing active, public and shared transport opportunities and use (5)
- _____ Safe and sustainable water supply and improved waterways (6)

End of Block: New Projects

Start of Block: Demographic Information

Q14 Gender

- ☐ Male (1)
 - ☐ Female (2)
 - ☐ Other (3)
-

Q15 Age

- ☐ Under 18 (1)
 - ☐ 18 - 24 (2)
 - ☐ 25 - 34 (3)
 - ☐ 35 - 44 (4)
 - ☐ 45 - 54 (5)
 - ☐ 55 - 64 (6)
 - ☐ 65 - 74 (7)
 - ☐ 75 - 84 (8)
 - ☐ 85 or older (9)
-

Q16 Ethnicity

- ☐ European (1)
 - ☐ Māori (2)
 - ☐ Pacific Islander (3)
 - ☐ Asian (4)
 - ☐ Middle Eastern, Latin American, African (5)
 - ☐ Other (6)
-

Q17 Highest Qualification

- ☐ No qualifications (1)
- ☐ Overseas secondary school qualification (2)
- ☐ Level 1, 2, or 3 certificate eg. NCEA level 1,2, or 3 (3)
- ☐ Level 4 certificate eg. apprenticeship (4)
- ☐ Level 5 or 6 certificate eg. advanced trade cert (5)
- ☐ Bachelors degree or level 7 certificate (6)
- ☐ Honours or post-graduate degree (7)
- ☐ Masters degree (8)
- ☐ PhD Doctorate (9)

End of Block: Demographic Information

Start of Block: Further Research Participation

Q28 *Click the arrow button once you have finished*

Thank you for taking time to fill out this survey. The information you have given will be used to inform Smart Cities Christchurch about resident and community wants and needs, in terms of new projects and technology being implemented in the city.

If you are interested in taking part in further research, could you please follow the link below to take you to another survey about taking part in a **focus group** discussing this.
This is completely optional but would add great value to my research.

http://canterbury.qualtrics.com/jfe/form/SV_0dYKV4w6VmJwKtD

Thanks again.

Hayden Slaughter

Hayden Slaughter.
hayden.slaughter@pg.canterbury.ac.nz

End of Block: Further Research Participation

3 Appendix 3

Information form for stakeholder interviews.

The University of Canterbury Geography Department
Telephone: +64 277 387 798
Email: hayden.slaughter@pg.canterbury.ac.nz
01/06/2017



Generating actionable and meaningful data from a Smart Cities project **Hayden Slaughter – Interview information form**

My name is Hayden Slaughter, I am a Masters of Science thesis student, majoring in Geography at The University of Canterbury. My research project involves understanding community perceptions of The Christchurch City Council's Smart Cities Project.

The Christchurch City Council is working on initiatives to make Christchurch a smart city. This involves making a city that is smart, safe, and well-functioning using a variety of tools to display information. My research will focus on understanding how to make this data meaningful and actionable to the target audience (i.e. community groups and residents of Christchurch generally), and data gathering for mapping and understanding community needs relating to the smart city project(s) in Christchurch City.

Meaningful, in this case, means the data is easy to understand by people in Christchurch. Actionable means the information will be easy to use by these people.

A smart city is one that uses new technology-driven projects to improve the way the city can be used by people. This could be through improving access to information about the city, helping people to find car parking, offering city-wide free wifi, reducing the number of overflowing bins on streets, creating maps displaying large amounts of information about the city, and may other projects similar to this. Smart cities aim to improve the function of the city for its citizens.

For more information on the smart city, see <http://www.linz.govt.nz/about-linz/what-were-doing/projects/smart-cities>, or email me directly.

Participation is voluntary and you have the right to withdraw at any stage without penalty. You may ask for your raw data to be returned to you or destroyed at any point. If you withdraw, I will remove information relating to you.

The results of the project may be published, but you can be assured of the complete confidentiality of data gathered in this investigation: your identity will not be made public. If you would like to withdraw this information, you may.

To ensure anonymity and confidentiality, all data, results, and information about yourself will be kept between myself, and my supervisors. This will be kept locked in a set of drawers until the completion of the Masters project. Once complete, this will be stored securely for five years, and destroyed after this date. The results, minus any personal information will be kept by The Christchurch City Council to inform the Smart City program, and any other relevant projects. At no point will personal details be released. A thesis is a public document and will be available through the UCLibrary.

Please indicate to the researcher on the consent form if you would like to receive a copy of the summary of results of the project.

The project is being carried out as a part of a Masters degree program, and as part of the Christchurch City Council Smart City project. It will also be used as research to support The National Science Challenge 11 (NSC) (Building Better Homes Towns and Cities) (more information is available here <http://www.buildingbetter.nz/>), and could be used in publications and reports in collaboration with other researchers. This will be completed by Hayden John Slaughter under the supervision of Dr Malcolm Campbell, who can be contacted at malcolm.campbell@canterbury.ac.nz. Please contact Dr Malcolm Campbell with any questions about this research.

This project has been reviewed and approved by the University of Canterbury Human Ethics Committee, and participants should address any complaints to The Chair, Human Ethics Committee, University of Canterbury, Private Bag 4800, Christchurch (human-ethics@canterbury.ac.nz).

If you agree to participate in the study, you are asked to complete the consent form and return directly to me (Hayden Slaughter) before taking part in any part of the research

4 Appendix 4

Information form for focus groups

The University of Canterbury Geography Department
Telephone: +64 277 387 798
Email: hayden.slaughter@pg.canterbury.ac.nz
01/06/2017



Generating actionable and meaningful data from a Smart Cities project Hayden Slaughter - Focus group information form

My name is Hayden Slaughter, I am a Masters of Science thesis student, majoring in Geography at The University of Canterbury. My research project involves understanding community perceptions of The Christchurch City Council's Smart Cities Project.

The Christchurch City Council is working on initiatives to make Christchurch a smart city. This involves making a city that is smart, safe, and well-functioning using a variety of tools to display information. My research will focus on understanding how to make this data meaningful and actionable to the target audience (i.e. community groups and residents of Christchurch generally), and data gathering for mapping and understanding community needs relating to the smart city project(s) in Christchurch City.

Meaningful, in this case, means the data is easy to understand by people in Christchurch. Actionable means the information will be easy to use by these people.

A smart city is one that uses new technology-driven projects to improve the way the city can be used by people. This could be through improving access to information about the city, helping people to find car parking, offering city-wide free wifi, reducing the number of overflowing bins on streets, creating maps displaying large amounts of information about the city, and may other projects similar to this. Smart cities aim to improve the function of the city for its citizens.

For more information on the smart city, see <http://www.linz.govt.nz/about-linz/what-were-doing/projects/smart-cities>, or email me directly.

Participation is voluntary and you have the right to withdraw at any stage without penalty. You may ask for your raw data to be returned to you or destroyed at any point. If you withdraw, I will remove information relating to you.

You are required to keep all information in this focus group confidential. This means no discussion of the focus group proceedings at any point after the conclusion of the focus group.

The results of the project may be published, but you can be assured of the complete confidentiality of data gathered in this investigation: your identity will not be made public. If you would like to withdraw this information, you may.

To ensure anonymity and confidentiality, all data, results, and information about yourself will be kept between myself, and my supervisors. This will be kept locked in a set of drawers until the completion of the Masters project. Once complete, this will be stored securely for five years, and destroyed after this date. The results, minus any personal information will be kept by The Christchurch City Council to inform the Smart City program, and any other relevant projects. At no point will personal details be released. A thesis is a public document and will be available through the UCLibrary. You will not be identified as a participant in this focus group at any point.

Please indicate to the researcher on the consent form if you would like to receive a copy of the summary of results of the project.

The project is being carried out as a part of a Masters degree program, and as part of the Christchurch City Council Smart City project. It will also be used as research to support The National Science Challenge 11 (NSC) (Building Better Homes Towns and Cities) (more information is available here <http://www.buildingbetter.nz/>), and could be used in publications and reports in collaboration with other researchers. This will be completed by Hayden John Slaughter under the supervision of Dr Malcolm Campbell, who can be contacted at malcolm.campbell@canterbury.ac.nz. Please contact Dr Malcolm Campbell with any questions about this research.

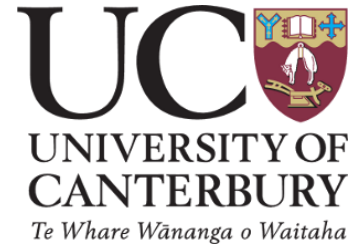
This project has been reviewed and approved by the University of Canterbury Human Ethics Committee, and participants should address any complaints to The Chair, Human Ethics Committee, University of Canterbury, Private Bag 4800, Christchurch (human-ethics@canterbury.ac.nz).

If you agree to participate in the study, you are asked to complete the consent form and return directly to me (Hayden Slaughter) before taking part in any part of the research

5 Appendix 5

Consent form for stakeholder interviews.

The University of Canterbury Geography Department
Telephone: +64 277 387 798
Email: hayden.slaughter@pg.canterbury.ac.nz



Generating actionable intelligence and meaningful data from a Smart Cities project – Stakeholder interview consent form

- ☐ I have been given a full explanation of this project and have had the opportunity to ask questions.
- ☐ I understand what is required of me if I agree to take part in the research.
- ☐ I understand that participation is voluntary and I may withdraw at any time without penalt, before the 1st of February 2018.
- ☐ I understand that any information provided will be kept confidential to the researcher. No personal information will be used to identify me in any part of the research.
- ☐ I understand all information provided will be kept securely by the researcher.
- ☐ I understand the risks associated with taking part and how they will be managed.
- ☐ I understand that I can contact the researcher Hayden John Slaughter hayden.slaughter@pg.canterbury.ac.nz or supervisor Dr Malcolm Campbell, who can be contacted at malcolm.campbell@canterbury.ac.nz.
- ☐ If I would like a summary of the results of the project, I can provide my email address below.
- ☐ By signing below, I agree to participate in this research project.

Name: _____

Signed: _____

Date: _____ Email address: _____

6 Appendix 6

Consent form for focus groups

The University of Canterbury Geography Department
Telephone: +64 277 387 798
Email: hayden.slaughter@pg.canterbury.ac.nz



Generating actionable intelligence and meaningful data from a Smart Cities project – Focus group participant

- ☐ I have been given a full explanation of this project and have had the opportunity to ask questions.
- ☐ I understand what is required of me if I agree to take part in the research.
- ☐ I understand all discussion during the focus group will be kept confidential to myself and no information will leave the focus group session.
- ☐ I understand that no information from the notes I am sent after participating in the focus group will be shared with anyone other than the researcher.
- ☐ You are required to keep all information in this focus group confidential. This means no discussion of the focus group proceedings at any point after the conclusion of the focus group.
- ☐ I understand that participation is voluntary and I may withdraw at any time without penalty.
- ☐ I understand that any information provided will be kept confidential to the researcher. No personal information will be used to identify me in any part of the research.
- ☐ I understand all information provided will be kept securely by the researcher.
- ☐ I understand the risks associated with taking part and how they will be managed.
- ☐ I understand this focus group will be recorded, and this will be kept by Hayden Slaughter and remain confidential
- ☐ I understand that I will be given the opportunity to check and approve any quotes I use in this focus group.
- ☐ I understand I can pull out of this research at any point before the 1st of February 2018
- ☐ I understand that this discussion may involve the topic of the Christchurch Earthquake Sequence, and if at any time during this session I wish to remove myself I can.
- ☐ I understand that I can contact the researcher Hayden John Slaughter hayden.slaughter@pg.canterbury.ac.nz or supervisor Dr Malcolm Campbell, who can be contacted at malcolm.campbell@canterbury.ac.nz.
- ☐ If I would like a summary of the results of the project, I can provide my email address below.
- ☐ By signing below, I agree to participate in this research project.

Name: _____

Signed: _____

Date: _____ Email address: _____